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HUMAN HEALTH RISK ASSESSMENT WORK PLAN FOR THE GE AIRCRAFT ENGINES EVANDALE FACILITY

Prepared By:

ChemRisk - McLaren/Hart
Cleveland, Ohio

Project No. 080803673001
January 17, 1997

DRAFT

HUMAN HEALTH RISK ASSESSMENT WORK PLAN

FOR THE

GE AIRCRAFT ENGINES

EVENDALE FACILITY

January 17, 1997

Prepared for:

General Electric Aircraft Engines
General Electric Company
Cincinnati, OH 45215

Prepared by:

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GE Aircraft Engines

General Electric Company
One Neumann Way M/D N123
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(513) 243-6272

January 17, 1997

Daniel Patulski
USEPA Region V
RCRA Permitting Section
5HR-13
77 West Jackson Boulevard
Chicago, IL 60604

Re: General Electric Company
GE Aircraft Engines
OHD 000 817 312

Dear Mr. Patulski:

Enclosed are two copies of the Draft Human Health Risk Assessment Work Plan for the GE Aircraft Engines Evendale Facility, January 17, 1997 prepared by Chem Risk.

If you have any questions, please contact me at (513) 243-6272.

Sincerely,

Gregory H. Jaspers

Gregory H. Jaspers, PE
Sr. Environmental Engineer

Enclosure

cc: C. Kotsko, OEPA
G. Walters, USAF
W. Killoran
M. Norman, VSSP
J. Boneberg, OBG
M. Bono, Chem Risk
B. Spackman
V. Ord, BUSTR

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1.0 INTRODUCTION

This Human Health Risk Assessment Work Plan was prepared by ChemRisk® on behalf of General Electric (GE) Aircraft Engines for the Evendale, Ohio facility. The Work Plan presents the human health risk assessment methodology and relevant technical information that will be used to conduct a risk assessment study based on results of the Resource Conservation & Recovery Act (RCRA) Facility Investigation (RFI) for the GE Aircraft Engines Evendale facility. The purpose of the risk assessment is to provide a risk-based interpretation of the data collected during the RFI phase of the corrective action process and provide estimates of potential health risks. The results of the risk assessment can also be used to prioritize corrective action and identify areas/solid waste management units (SWMUs) that may be considered for no further action. The objective of this Work Plan is to provide the technical approach and basis associated with the risk assessment process for characterizing exposures and potential health risks to humans.

1.1 Site Description

The following site description was summarized from the RFI report (OBG, 1995a).

The GE Aircraft Engines Evendale facility (the site) is located on an approximately 400-acre site at One Neumann Way in Evendale, Ohio (Figure 1-1). It is bordered by Interstate Route 75 to the west, Conrail railroad tracks to the east, Glendale - Milford Road (Route 126) to the north, and Shepherd Lane to the south (Figure 1-2).

The site is located in southwestern Ohio's Hamilton County, approximately 12 miles north of Cincinnati. The site is situated in the Mill Creek Valley between the West Fork and Mill Creek. The area forms part of the Till Plains section of the Central Lowland Province of Ohio, a broad plateau which has been dissected by a number of large valleys (OBG, 1995a). Mill Creek Valley, which trends north-northeast to south-southwest, is one of these dissecting valleys. The valley floor extends to a width of about two miles, and land surface elevations rise abruptly 100 to 300 ft along the valley walls.

The site topography is characterized by a gently sloping land surface, with ground elevations ranging from 550 to 580 ft above mean sea level (msl). Locally, the valley is drained by the East and West Forks of Mill Creek and Mill Creek. Mill Creek continues flowing south until it empties into the Ohio River at Cincinnati.

Industrial properties located east of the site include a Formica plant, the Cavet asphalt plant (formerly Darling Rendering), Cincinnati Drum, Morton International, Inc. and Pristine, Inc. Cincinnati Drum is an active facility that provides cleaning, reclamation and recycling of steel drums. Morton International manufactures synthetic stabilizers and plasticizers. The Cincinnati Drum and Pristine sites are the location of the former International Minerals Corporation plant which manufactured sulfuric acid and fertilizers. Pristine, Inc. operated as a liquid waste disposal unit. Operations at the three-acre Pristine site ceased in 1981, and the site was added to the USEPA National Priorities List in December 1982. The Record of Decision was issued in 1988 and amended in 1990. Remedial actions proposed at the Pristine site include decontamination of structures, mobile on-site thermal treatment of soils and sediments, *in situ* soil vapor extraction and ground water extraction and treatment. Chemicals of interest (COIs) at the Pristine site include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and pesticides.

The City of Reading's former municipal landfill, incinerator and ash fields are also located adjacent to the site.

1.2 Site History

The following site history information is summarized from the RFI report (OBG, 1995a).

The GE Evendale plant was built in the early 1940s. General Electric began operations at the Evendale facility in 1948, and soon thereafter, began manufacturing engines for military aircraft. In the early 1960s, GE began manufacturing engines for commercial aircraft. In 1989, GE acquired the adjacent Ford Motor Company warehouse and the U.S. Air Force Plant No. 36 (Plant 36) complex.

Former Plant 36 is situated on a 66.4-acre parcel of land located within the confines of property now owned by GE Aircraft Engines, Inc. This area was used to support and supplement the activities of the adjacent site. The facility includes a former nuclear engine research and test facility which was housed in Buildings C-west and D, and four large above-ground storage tanks for the storage of diesel and jet fuels. In addition to the above-ground tanks, there were 21 underground storage tanks for the storage of jet and diesel fuels, oils, gasoline, and water. The underground storage tanks have been removed.

The site includes a variety of manufacturing and assembly buildings, test cells, shipping/receiving centers, office and storage space, as well as a complex network of utilities to support the operations. Waste materials generated at the site have included solid waste (paper, cardboard, construction debris, scrap metals, fly ash, batteries, etc.), sludges (water softening, electroplating, oil/water separators, wastewater treatment, etc.) and liquids (wastewater, waste acids/alkalis, waste solvents, waste oils, etc.). On-site facilities for waste management have included container storage areas, tanks, landfills, landfarms, surface impoundments, paper incinerators, wastewater pretreatment systems, waste recycling areas and air pollution equipment.

A RCRA Facility Assessment (RFA) performed by the USEPA Region 5 and subsequent investigations identified SWMUs and areas of concern (AOCs) (OBG, 1995a). A list of SWMUs and AOCs at the site is provided in Table 1-1. Seventy-three of these locations were targeted for investigation under the RFI program. Fifty of these targeted areas are SWMUs which have a potential for release of hazardous constituents. Twenty-three additional areas were identified as AOCs which are potential sources resulting from leaks or spills not associated with SWMUs. Thirteen of the targeted areas have been identified at the former Air Force Plant 36 as part of an Installation Restoration Program (IRP) investigation. The location of these areas is shown on Figure 1-3.

1.3 Overview of Risk Assessment Approach

The approach that will be followed for conducting the risk assessment for the site will incorporate the four fundamental components associated with the human health risk assessment process: (1) Data

Evaluation; (2) Exposure Assessment; (3) Toxicity Assessment; and (4) Risk Characterization. These four components are described in detail in Sections 4 through 7 of this work plan.

The methodology for conducting the risk assessment will generally follow that presented in the *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual: Part A, Baseline Risk Assessment (RAGS, Part A)* (USEPA, 1989a). Additionally, several more recent regulatory guidance documents will be considered during the preparation of the risk assessment, as appropriate.

- *Exposure Factors Handbook.* USEPA, 1989b. Office of Health and Environmental Assessment, Washington, D.C. May.

- *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* Interim Final. USEPA, 1991a. Office of Solid Waste and Emergency and Remedial Response. OSWER Directive 9285.6-03. Washington, D.C.

- *Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, interim. USEPA, 1991b. Office of Emergency and Remedial Response, Washington, D.C. PB92-963333.

- *Dermal Exposure Assessment: Principles and Applications.* USEPA, 1992a. USEPA Office of Research and Development. Washington, D.C. EPA/600/8-91/011B.

- *Guidance for Exposure Assessment.* USEPA, 1992b. Federal Register 59(104)22888-22936. March 29, 1992.

- *Policy for Risk Characterization at the U.S. Environmental Protection Agency.* USEPA, 1995a.

These regulatory references provide general guidance and methodologies for conducting human health risk assessments and encourage reliance on site-specific information, as well as information in the peer-reviewed scientific literature. Accordingly, site-specific information and more recent scientific data will be utilized, when available. Risk assessment analyses for the site will utilize the data collected during the RFI.

As discussed with U.S.EPA Region 5 project members in Chicago on October 22, 1996, two distinct elements are presented in this risk assessment work plan:

1. the results of data evaluation, identification of potential chemicals of interest, and the identification of potential receptors; and

2. the methodology for conducting the quantitative risk assessment.

The inclusion of data evaluation and receptor identification in the Work Plan will enable the risk assessment to focus on the key contributors to potential human health risks at or near the site.

The results of the risk assessment will provide useful information to determine (1) no further action, (2) a decision to conduct further investigation, or (3) a decision to perform a Corrective Measures Study (CMS) without any further risk assessment studies.

1.4 Work Plan Organization

The remainder of this Work Plan is organized as follows:

2.0 *Project Organization* - This section presents the responsibilities and lines of communication for personnel involved in corrective action and risk assessment activities.

3.0 *Potential Receptor Identification Report* - This section presents the results of a demographic study for the GE Aircraft Engines Facility in Evendale, Ohio and the surrounding area.

4.0 *Data Evaluation* - This section presents the data evaluation methodology and the results of a preliminary data evaluation.

5.0 *Exposure Assessment* - This section presents the exposure assessment methodology and the results of the receptor identification effort.

6.0 *Toxicity Assessment* - This section presents the toxicity information to be used for risk assessment at the GE Aircraft Engines Evendale site.

7.0 *Risk Characterization* - This section presents the risk characterization methodology.

8.0 *References*

TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
1	Bldg. 519 Hazardous Waste Container Storage Area
2	Bldg. 509 Hazardous Waste Container Storage Area
3	Former Bldg. 509 Underground Waste Oil Tank
4	Bldg. 509 Waste Oil Tank
5	Bldg. 509 Waste 1,1,1 TCA Tank
6	Bldg. 509 Sump
7	Rainwater Drum Storage Area
8	Temporary Drum Storage Area (Former Bldg. 509)
9	Waste Oil Drum Storage Area
10	BFI Special Waste Storage Container
11	Scrap Metal Storage Bins
12	Drum Crusher Unit
13	Crushed Drum Storage Bin
14	Battery Storage Area
15	Radioactive Waste Storage Area
16	Weigh Station Sump
17	Reading Road Landfill
18	Sludge Basin Landfill
19	East Landfarm
20	Former North Landfarm
21	Former 508 Sludge Basin
22	Former 508 Sludge Basin
23	Former Bldg. 313 Sludge Drying Bed Site
24	Former Sermetel Basin A
25	Former Sermetel Basin B
26	Active Sermetel Basin and Unloading Station
27	Former Lime Precipitate Basin 1
28	Former Lime Precipitate Basin 2
29	Lime Precipitate Basin 3
30	Lime Precipitate Basin 4
31	Lime Precipitate Basin 5
32	304A Basin
33	405A Basin
34	ECM Basin

TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
35	Facility Chip Bins
36	Chip Transfer Stations
37	Chip Transfer Stations
38	Chip Transfer Stations
39	Chip Transfer Stations
40	Former Bldg. H Chip Storage Pad
41	Chip Piles
42 (SS-20)[a]	Former Chip Loading Area
43	Former Paper Collection Area
44	Bldg. 704 Waste Collection Station
45	Fmr. Bldg. 313 Codep Pile (No action if pile analyzed)
46	Former Bldg. M Incinerator
47	Former Bldg. 417 Incinerator
48	Bldg. 704 Incinerator
49	Former Bldg. 705 Hazardous Waste Storage Area
50	Former Bldg. 705 Nonhazardous Waste Storage Area
51	Deleted
52	Bldg. 800 Hazardous Waste Drum Storage Area
53	Deleted
54	Asbestos Dumpster
55	Former EMTL Underground Waste Oil Tank
56	Lime Thickener Tank
57	Lime Thickener Tank
58	Bldg. 421 Fly Ash Storage Tank
59	Ultrafiltration Concentrate Tank
60	Tramp Oil Tank
61	Underground Waste Oil/Fuel Storage Tank 304-7 (old)
62	Underground Waste Oil/Fuel Storage Tank 417-2
63	Underground Waste Oil/Fuel Storage Tank 417-3
64	Underground Waste Oil/Fuel Storage Tank 505-28 (old)
65	Underground Waste Oil/Fuel Storage Tank 507-4
66	Deleted
67	Underground Waste Oil/Fuel Storage Tank 304-7 (new)
68	Underground Waste Oil/Fuel Storage Tank 505-28 (new)

TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
69	Waste Fuel Collection Tank 301-1
70	Waste Fuel Collection Tank 303-2
71	Deleted
72 (ST-14)[a]	Waste Fuel Collection Tank D-1
73	Titanium Clean Line Alkaline Sludge Collect. System
74	Former 1,1,1 TCA Distillation Site
75	Mobile Corrosive Waste Tank
76	Mobile Corrosive Waste Tank
77	Former Bldg. 415 Electroplating Treatment Basin
78	ECM Sludge Filter Press
79	Former Bldg. 800 Wastewater Pretreatment System
80	Former Ammonia Wastewater Neutralization Site
81	Bldg. 800 Wastewater Pretreatment System
82	Bldg. 800 Wastewater Pretreatment System
83	Bldg. 800 Wastewater Pretreatment System
84	Bldg. 800 Wastewater Pretreatment System
85	Oil/Water Separator 200
86	Oil/Water Separator 301-2
87	Oil/Water Separator 303-1
88	Oil/Water Separator 303-3
89	Oil/Water Separator 304-2
90	Oil/Water Separator 305-1
91	Oil/Water Separator 407-1
92	Oil/Water Separator 417
93	Oil/Water Separator 500-1E
94	Oil/Water Separator 500-1W
95	Oil/Water Separator 500-2
96	Oil/Water Separator 500-4
97	Oil/Water Separator 702
98	Oil/Water Separator 703-1E
99	Oil/Water Separator 703-1W
100	Oil/Water Separator 707-1
101	Oil/Water Separator B-1
102	Oil/Water Separator C-1

TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
103	Oil/Water Separator J-1
104	Oil/Water Separator SFF-1
105	Waste Oil Sludge Removal Tank (Removed)
106	Acid Neutralization System - Bldg. C
107	Acid Neutraliz. System - Bldg. 800 Quality Labs
108	Acid Neutraliz. System - Bldg. 700 Macroetch
109	Acid Neutraliz. System - Bldg. 700 Ti Clean
110	Acid Neutraliz. System - Bldg. 700 Process Room
111	Acid Neutraliz. System - Bldg. 200 Process Room
112	Acid Neutraliz. System - Bldg. D Plating Line
113	Acid Neutraliz. System - Bldg. D Cleaning Line
114	Acid Neutraliz. System - Bldg. 715 ES&Stem
115	Acid Neutraliz. System - Bldg. 700 Development Labs
116	Facility Test Cell Drains
117 (SD-22)[a]	Process Sewer System - Oil/Water Sewer System
118 (SD-23)[a]	Process Sewer System - Sanitary Sewer
119 (SD-24)[a]	Process Sewer System - Stormwater Sewer
120	Process Sewer System - Former Sludge Line
121	Process Sewer System - Waste Sewer
122	Stormwater Pumphouse 422
123	Stormwater Pumphouse 423
124	Stormwater Pumphouse 506
125	Concrete Lined Drainage Ditch - North and East
126	Concrete Lined Drainage Ditch - West
127 (SD-25)[a]	Unlined Drainage Ditch
128	Facility Cyclones
129	Thermal Plasma Spray Unit Multiclone
130	Facility Air Scrubbers
131	Laser Drill No. 2 Electrostatic Precipitator
132	Paint Spray Booth Air Pollution Control Equipment
133	Facility Vapor Degreasers (deleted)
134	Kirtsite Foundry
135	Facility Baghouses
136	Well Cuttings Drum Storage Area

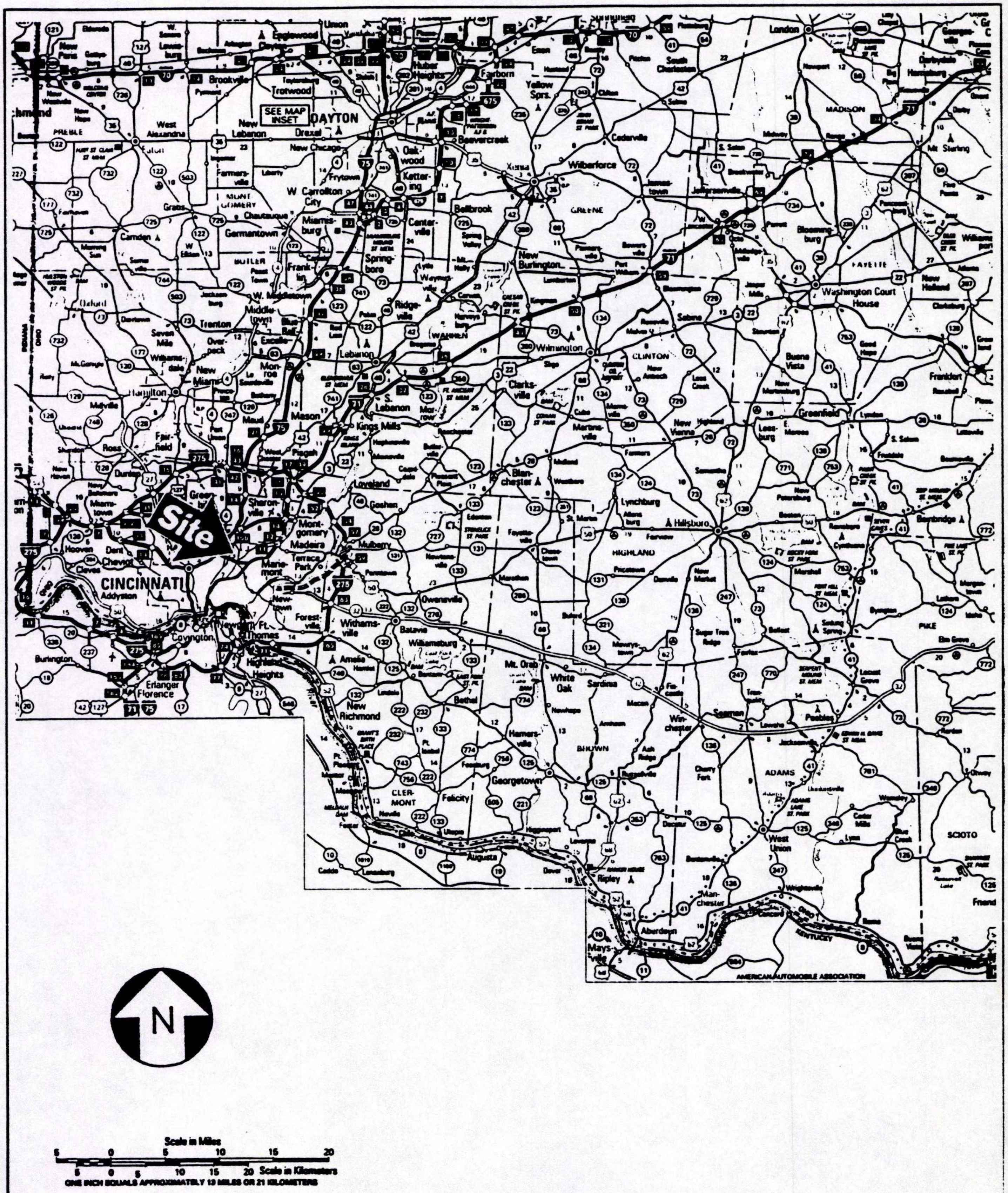
TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
137	Well Cuttings Storage Pile
138	Outside PCB Transformer Station Sumps
139	Safety Kleen Units
140	Former Lime Sludge Sluiceway
141 (SD-26)[a]	Gravel Media Coalescing Separator
142	Bldg. 800 Machine Sump (Added 1/16/91)
143	Bldg. 800, G1, Chip Transfer Station (Added 7/15/93)
AOC A (SS-27)[a]	Bldg. P Fuel Spill
AOC B	Bldg. 300 Fuel Spill
AOC C	507 Underground Tank Farm Spill
AOC D (SS-28)[a]	Bldg. B Fuel Spill No. 1
AOC E	Bldg. 303 Fuel Spill
AOC F	Bldg. 517 Fuel Spill
AOC G (SD-23)[a]	South Fuel Farm Spill No. 1
AOC H	ECM Brine Tank Spill
AOC I (SD-29)[a]	Bldg. B Fuel Spill No. 2
AOC J	308 Fuel Farm Spill
AOC K	ATF Waste Oil/Fuel Spill
AOC L	Blg. 304 Fuel Spill
AOC M	South Fuel Farm Spill No. 2
AOC N	South Fuel Farm Spill No. 3
AOC O	Bldg. 703 Fuel Spill No. 1
AOC P	Bldg. 700 Coolant Spill
AOC Q	Bldg. 518 Waste Oil Spill
AOC R	Bldg. 700 Sulfuric Acid Spill
AOC S	Bldg. 307 Jet Fuel Spill
AOC T	Bldg. 703 Fuel Spill No. 2
AOC U (SS-30)[a]	South Fuel Farm Spill No. 4
AOC V	Radioactive Spill Site
AOC W1	Inactive Underground Product Storage Tanks 306-8
AOC W2	Inactive Underground Product Storage Tanks 417-E M-1
AOC W3	Inactive Underground Product Storage Tanks 505-1 to 27
AOC W4	Inactive Underground Product Storage Tanks 507-5, 6, 13, 1
AOC W5	Inactive Underground Product Storage Tanks 700 N-1, M-1

TABLE 1-1
LIST OF SWMUs AND AREAS OF CONCERN
GEAE EVENDALE FACILITY

SWMU No.	Unit Name
AOC W6	Inactive Underground Product Storage Tanks 703-2
AOC W7	Inactive Underground Product Storage Tanks 703-1 to 4
AOC W8	Inactive Underground Product Storage Tanks B-3, 4
AOC-W9	Inactive Underground Product Storage Tanks C-1 to 3
AOC-W1	Inactive Underground Product Storage Tanks D-1 to 5
AOC DS	306 Drum Storage Area
AOC WD	704 Waste Drum Accumulation
AOC LD	Bldg. 700 South Loading Dock
AOC PST	TCE/TCA Product Storage Tanks
-	Perimeter Well Near Lime Precip. Basins
500-4	Underground Storage Tank 500-4
-	Ash Piles Near Lime Precip. Basins
500-3	Underground Storage Tank 500-3
UST 503	503-1 to 503-10 Tank Farm
800-1	Underground Storage Tank 800-1
700-3	Underground Storage Tank 700-3
700-4	Underground Storage Tank 700-4

a U.S. Air Force Installation Restoration Program (IRP) number in parentheses.



Reference: AAA 1995 United States/Canada/Mexico Road Atlas

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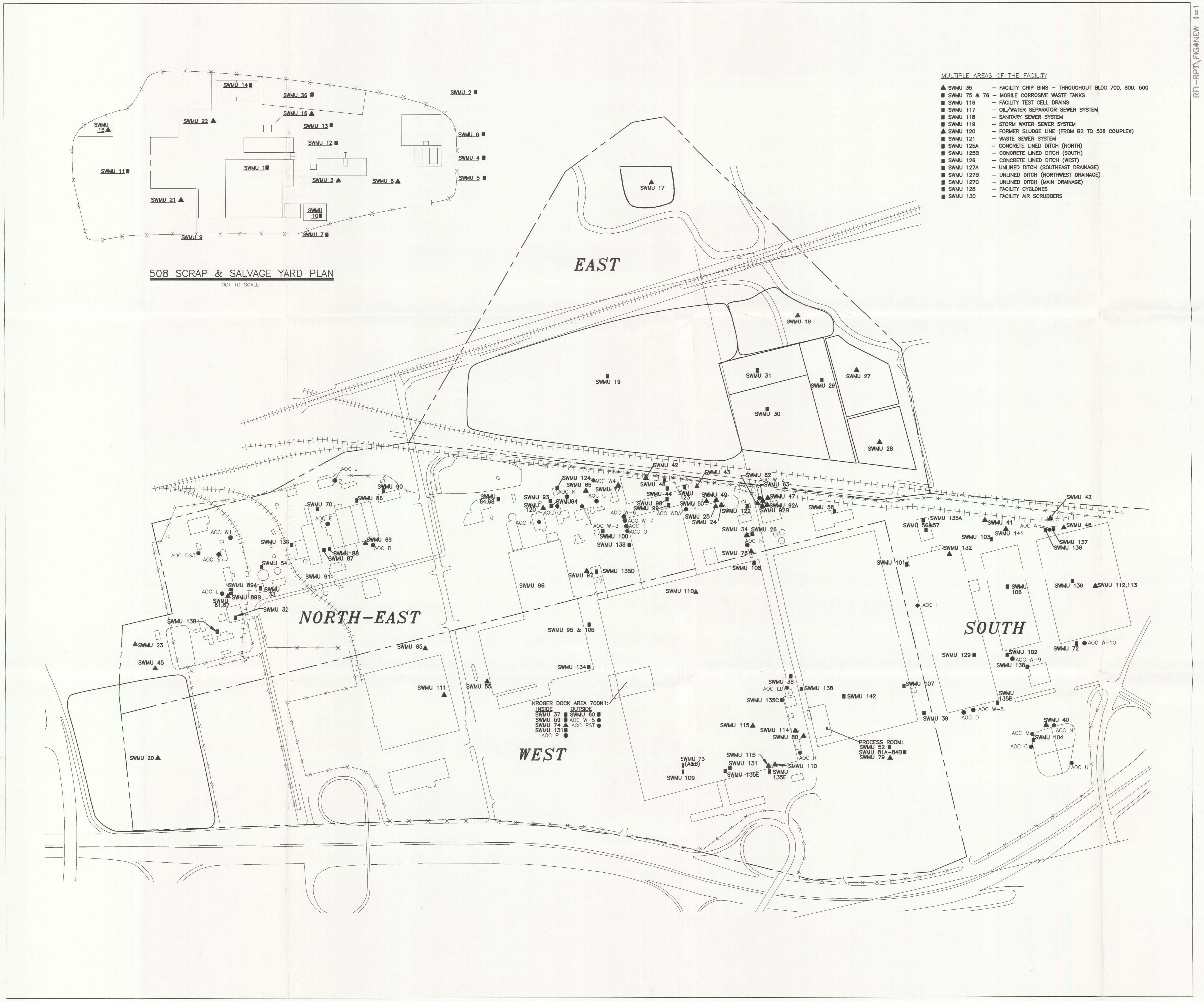
FIGURE 1-1
SITE LOCATION MAP
GEAE



LEGEND

■ – ACTIVE SOLID WASTE MANAGEMENT UNIT (SWMU)
▲ – INACTIVE SOLID WASTE MANAGEMENT UNIT (SWMU)
● – AREA OF CONCERN (AOC)
– INTERIM MEASURES FACILITIES

GENERAL ELECTRIC COMPANY
G.E. AIRCRAFT ENGINES
EVENDALE, OHIO

AREA OF
INVESTIGATION
FIGURE 1–3

NOT TO SCALE

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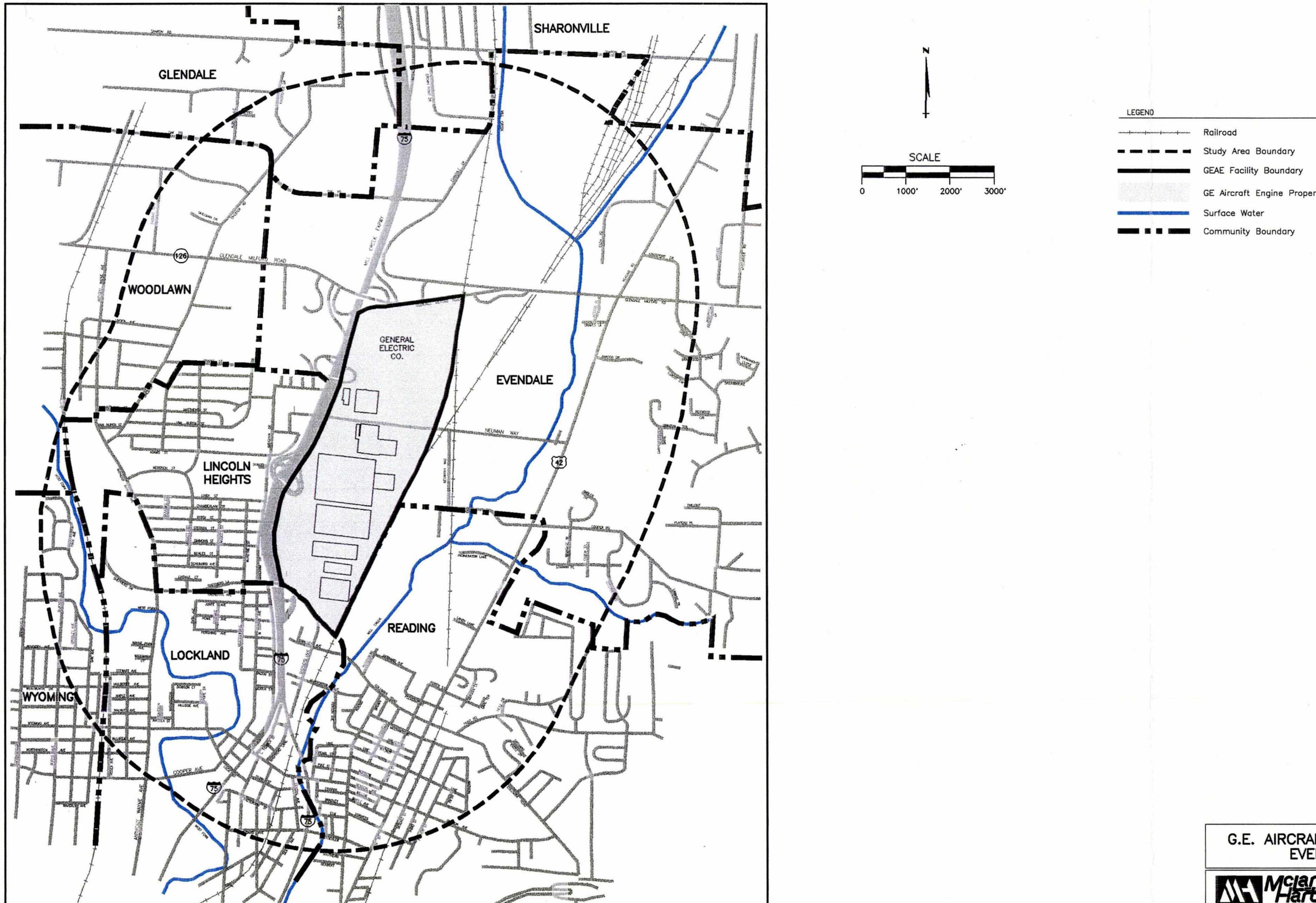
O'BRIEN & GERE
ENGINEERS, INC.



G.E. AIRCRAFT ENGINES FACILITY
EVENDALE, OHIO

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

DRWN: TML	DATE: 11-96
CHKD	DATE
APPD	DATE
SCALE	AS SHOWN

STUDY AREA

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DRAWING NUMBER
FIGURE 1-2

2.0 PROJECT ORGANIZATION AND PERSONNEL

This section presents the overall project organization and responsibilities for the corrective action process underway at the site (Section 2.1) and the ChemRisk® project team organization and responsibilities (Section 2.2).

2.1 Corrective Action Process Organization

The ongoing corrective action process at the facility involves several primary participants as summarized in Figure 2-1. The lines of communication and responsibilities under this process are described below.

- **General Electric Aircraft Engines**

  Responsibility
  - implementation of permit requirements

  Key Personnel
  - Gregory Jaspers, P.E. (Sr. Environmental Engineer - Project Director)

- **U.S. Environmental Protection Agency (USEPA) Region V**

  Responsibility
  - ensure compliance with permit requirements

  Key Personnel
  - Mario Mangino (Toxicologist)
  - Daniel Patulski (Project Coordinator)

- **O'Brien & Gere**

  Responsibility
  - implementation of RFI

  Key Personnel
  - Terry Woodward (Project Manager)

- **ChemRisk®**

  Responsibility
  - risk assessment support for RFI/CMS activities

  Key Personnel
  - Michael Bono (Project Manager)
  - Brent Finley (Principal-in-Charge)

2.2 ChemRisk® Project Team

The responsibilities and lines of communication for all human health risk assessment activities are summarized in Figure 2-2. The responsibilities associated with each position identified are described below.

- *Principle-In-Charge* - The Principle-In-Charge will be responsible for providing technical guidance and reviewing all major risk assessment work products.

- *Project Manager* - The Project Manager will have overall responsibility for ensuring that the project meets GE's and USEPA's objectives and ChemRisk® quality standards. The Project Manager will report directly to the GE Project Director and is responsible for technical quality control and project oversight. The Project Manager will assist the GE Project Director in the preparation and distribution of all risk assessment work products to those parties connected with the project.

- *Task Manager* - The Human Health Risk Assessment Task Manager will have responsibility for completion of all human health risk assessment tasks in accordance with the Work Plan. The Task Manager will coordinate all human health risk assessment activities and serve as the communication link between the risk assessment team and the Project Manager.

- *Technical Advisor* - The Human Health Risk Assessment Technical Advisor will provide technical advice on all human health risk assessment issues, provide strategic guidance, and review all risk assessment work products.

- *Technical Team* - The Human Health Risk Assessment Technical Team will perform the human health risk assessment activities in accordance with the Work Plan.

In addition to the above personnel, several support personnel will provide assistance to the Human Health Risk Assessment Team as described below.

- *Data Manager* - The Data Manager will be responsible for the management of the ChemRisk® Risk Assessment Database and interaction with O'Brien & Gere on all data need/transfer issues.

- *Modeler* - The Modeler will be responsible for all fate and transport modeling in support of risk assessment activities.

Figure 2-1
Project Organization Chart for the RCRA Corrective Action Process at the GE Aircraft Engines Evendale Facility

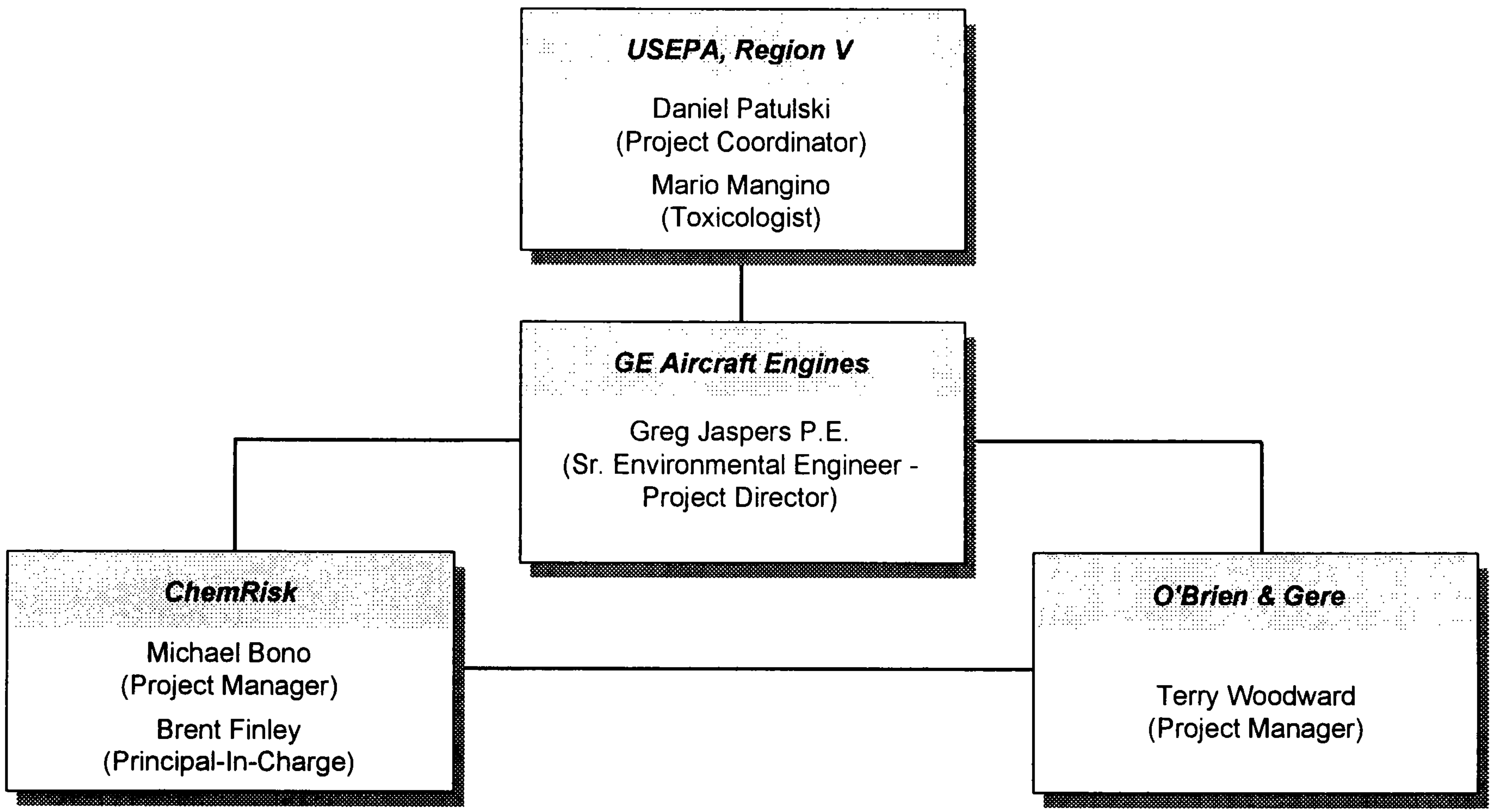

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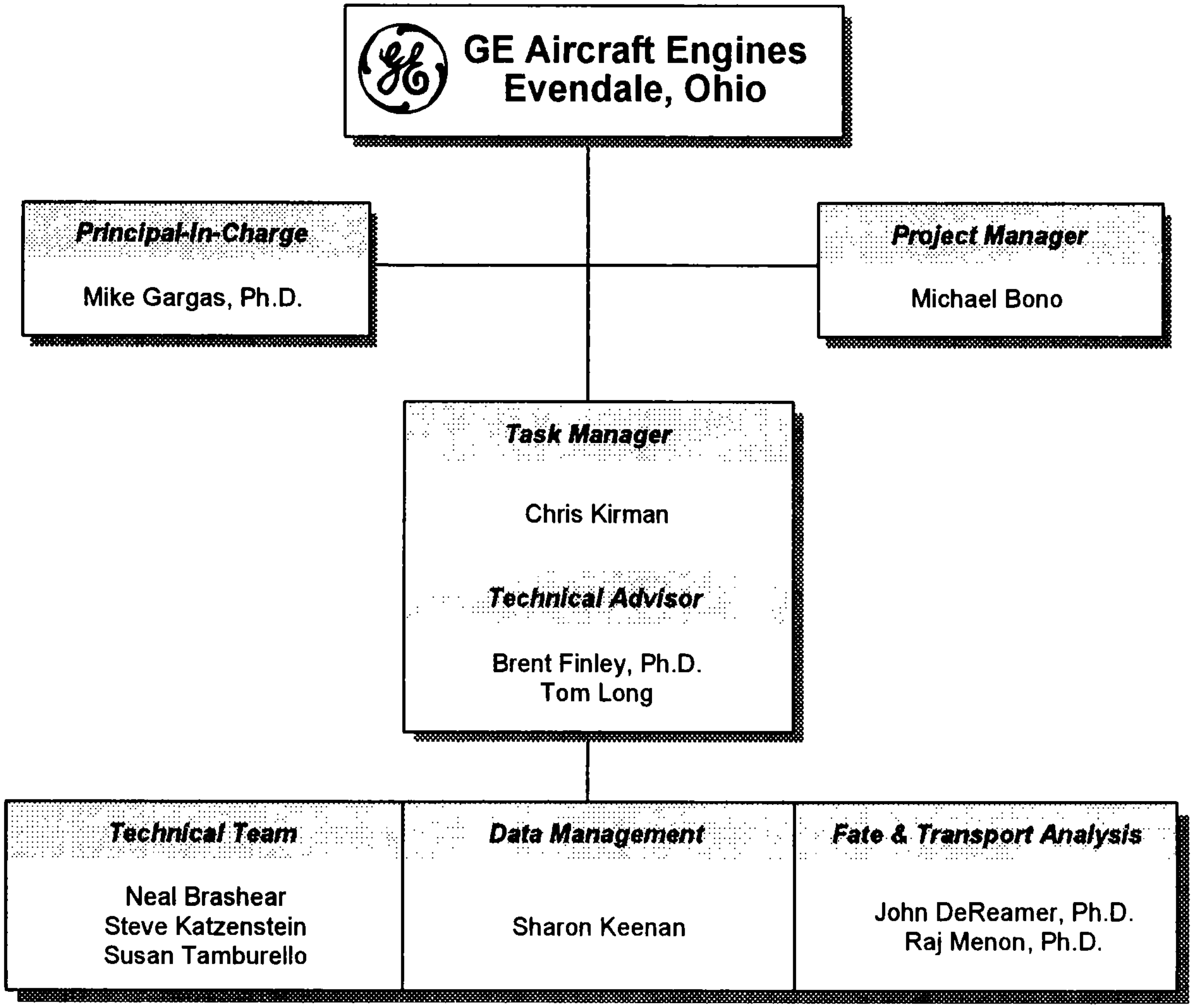
Figure 2-2
Human Health Risk Assessment Project Team



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3.0 POTENTIAL RECEPTOR IDENTIFICATION

3.1 Introduction

This section presents the results of a demographic study performed for the General Electric (GE) Aircraft Engines Facility in Evendale, Ohio and surrounding area (the study area) that characterizes land use, population activities, population types and population growth rates using information obtained from county, state and federal sources. Historical information, aerial photographs and field reconnaissance were also used to collect information for the demographic study. The purpose of this study was to identify the types of human activities that occur within the study area and determine how these activities may change in the future based on population growth estimates, zoning regulations and land use opportunities. This information was relied upon to identify potential receptors that may have contact with site-related chemicals and to quantify chemical uptake in the Exposure Assessment (Section 5.0).

The facility has undergone an RFI to characterize the nature and extent of releases of hazardous substances from SWMUs and AOCs. The results of the RFI are incorporated into the risk assessment along with the results of the demographic study so that potential human health exposures and health risks can be quantified. The RFI provides (1) environmental data on the concentration of chemicals in several media (soil, groundwater, sediments), (2) the nature and extent of chemical releases from SWMUs/AOCs, and (3) physical characterization of surface and subsurface conditions. Using this RFI information, the risk assessment will identify potentially exposed populations (current and future) and calculate estimates of risk using demographic and land use information presented in this section.

As described in the *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual, Part A (RAGS, Part A)* (USEPA, 1989a), the first step in evaluating exposures at a site is to characterize the site with respect to its physical characteristics and the human populations on and near the site. The output of this step is a qualitative evaluation of the site and surrounding populations with respect to those characteristics that influence exposure. This first step, characterization of exposure setting, is addressed with the information presented in this section. As defined in *RAGS, Part A* (USEPA, 1989a), the exposure setting is characterized from the elements described below.

- Characterization of the Physical Setting
- Characterization of Potentially Exposed Populations
  - ▸determine location of current populations relative to the site
  - ▸determine future land use
  - ▸identify subpopulations of potential concern

The characterization of physical setting includes: (1) climate, (2) meteorology, (3) geologic setting, (4) vegetation, (5) soil type, (6) groundwater hydrology, and (7) location and description of surface water (USEPA, 1989a). The characterization of potentially exposed populations involves the identification of populations on or near the site, activity patterns and the presence of sensitive subgroups (USEPA, 1989a).

3.1.1 Methodology

The characterization of the exposure setting for the site and surrounding area focused on current land use and the use of population statistics (*i.e.*, demographics). The specific components of this demographic study that are related to characterization of the exposure setting included: (1) site characterization including physical characteristics and historical information; (2) zoning regulations; (3) population statistics (*i.e.,* census data); (4) current land use; and (5) plausible future land use. For characterization purposes, the "study area" for this information gathering process was defined as the area within one-mile of the current GE property boundary (Figure 1-2). Based upon the geographic extent of the GE Aircraft Engines - Evendale facility and the urban nature of surrounding communities, the size of the study area (approximately 7.24 square miles) was considered adequate to characterize human activities that may be affected by site-related constituents.

The current (Section 3.5) and plausible future (Section 3.6) land uses within the study area were determined through several sources of information:

(1) local zoning regulations and maps (Evendale, 1995,1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993, 1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b);

(2) field reconnaissance conducted by ChemRisk® on November 10 and 11, 1996 to verify land use;

(3) aerial photographs (AIC, 1994);

(4) land development plans;

(5) the Greater Cincinnati Bell telephone directory; and

(6) Community guides (Evendale, 1996; Sharonville, 1996; and Wyoming, 1996).

The land use categories that were most applicable and the focus of this study included (1) residential, (2) commercial/industrial, (3) recreational (4) agricultural and (5) forest/field/wetland. The land use within the study area was confirmed during site visits conducted by ChemRisk® and through local sources. Future land use was determined by projections from city plans as well as land use plans for GE-owned property.

Human activities and activity patterns within the study area were characterized using local demographic information, site visits and population growth estimates obtained from the U.S. Department of Commerce (USDC), Bureau of the Census (1991; 1992a,b; 1993), and the Hamilton County Department of Economic Development (1993).

3.1.2 Section Organization

The remainder of this section is organized as follows:

Section 3.2 **Site Characterization** - A general overview of the site is presented including its operational history and important physical characteristics. Brief descriptions of the areas associated with the site are also provided.

Section 3.3 **Zoning Regulations** - Applicable zoning designations for each community within the study area are summarized.

Section 3.4 **Demographics** - Local demographic information is presented to characterize the general human population and activity patterns within the study area.

Section 3.5 **Current Land Use and Population Activities** - Current land use and associated populations within the study area are identified.

Section 3.6 **Plausible Future Land Use** - The most plausible future land uses for the study area are identified.

Section 3.7 **Summary**

3.2 Site Characterization

This section provides a general overview of the GE facility including its history and relevant physical features. As recommended by *RAGS, Part A* (USEPA, 1989a), site characteristics that are defined in this section include:

- climate/meteorology;
- surface water features;
- geologic setting; and
- groundwater hydrology.

3.2.1 Site Description

The GE Aircraft Engines facility is located approximately 12 miles north of Cincinnati in southwestern Ohio's Hamilton County. The current facility is situated on approximately 400 acres of land at One Neuman Way in the Village of Evendale (Figure 3-1). The site is bordered to the west by Interstate 75, to the east by Conrail railroad tracks, to the north by Glendale-Milford Road (Route 126) and to the south by Shepherd Lane (Figure 3-2).

3.2.2 Site History

The Evendale plant was built in the early 1940s and GE operations began in 1948. GE began manufacturing military aircraft engines in the late 1940s and commercial aircraft engines in the early

1960's (OBG, 1995a). The adjacent Ford Motor Company warehouse and the U.S. Air Force Plant No. 36 (Plant 36) complex were acquired by GE in 1989 (Figure 3-2).

The former Plant 36, located on approximately 66 acres of land, includes a former nuclear engine research and test facility and four large above-ground storage tanks (for jet and diesel fuels). In addition, there were 21 underground storage tanks for jet and diesel fuels, gasoline, oils and water storage. These underground storage tanks have been removed (OBG, 1995a).

On-site buildings include a variety of manufacturing and assembly buildings, test cells, shipping/receiving centers, office and storage space (OBG, 1995a). On-site waste generated includes solid waste (paper, cardboard, construction debris, scrap metals, fly ash, batteries), sludges (water softening, electroplating, oil/water separators, wastewater treatment), and liquids (wastewater, waste acids/alkalis, waste solvents, waste oils). Waste management facilities include container storage areas, tanks, landfills, surface impoundments, paper incinerators, wastewater pretreatment systems, waste recycling areas and air pollution equipment (OBG, 1995a).

3.2.3 General Physical Features

3.2.3.1 Climate/Meteorology

The GE Aircraft Engines facility is subject to climatological and meteorological conditions (*e.g.*, temperature, precipitation, wind speed) which vary widely within a year. Meteorological data were available from the National Climatic Data Center for the Greater Cincinnati area for the period of 1966 - 1995 (National Climatic Data Center, 1995). Based on this data, the average temperature for the area is 53.7°F with a minimum recorded temperature of -25°F and a maximum recorded temperature of 103°F. The average annual precipitation for the area is 40.82 inches with a range spanning 30 to 58 inches. The mean wind speed for the area is 9.1 mph from the south/southwest direction.

3.2.3.2 Surface Water

The GE Aircraft Engines Evendale facility is situated in the Mill Creek Valley between the West Fork and Mill Creek (Figure 3-2). The confluence of these two creeks lies approximately 1.5 miles south of the plant and Mill Creek continues flowing south until it empties into the Ohio River at Cincinnati. Facility surface water drainage is accomplished by a series of storm water sewer systems (OBG, 1995a). The storm water sewers collect test cell drainage, cooling tower blow-downs and storm water runoff throughout the site. The water collected in the sewers is generally directed to oil/water separators or to lined or unlined drainage ditches on-site. The storm sewers and ditches eventually discharge to Mill Creek through National Pollution Discharge Elimination Systems (NPDES)-permitted out falls (OBG, 1995a).

3.2.3.3 Geology

The study area is located in the Mill Creek Valley which overlies the ancestral valley of the Ohio River. The bedrock floor consists of low permeability, Ordivician aged, shale interbedded with thin layers of limestone (OBG, 1995a). A deep valley carved into bedrock by glaciation and erosion created a regional drainage system for southwestern Ohio. Sequences of unconsolidated sediments 150 to 300 feet thick filled the Ohio River Valley during the glaciation. This process resulted in a complex stratigraphy of glacial outwash, till, morainal and lacustrine deposits (OBG, 1995a). Much of the surface of the Mill Creek Valley is covered by glacial deposits and till covering the lower slopes along the valley margins (OBG, 1995a).

Five primary sedimentary facies exist in the Mill Creek Valley including a surficial formation of interbedded silt, sand and clay; an upper silt and clay formation; an upper fine to coarse sand and gravel formation; a lower silt and clay formation; and a lower, sand and gravel formation directly overlying bedrock (OBG, 1995a).

3.2.3.4 Groundwater

Three primary hydrogeologic units are present in the Mill Creek Valley: (1) a surficial water-bearing silty sand-clay formation (perched zone); (2) an upper sand and gravel aquifer comprised of the upper sand and gravel formation; and (3) a lower water-bearing sand and gravel aquifer which consists of the lower sand and gravel formation. The three hydrogeologic units in the Mill Creek Valley are separated by continuous layers of silt and clay (OBG, 1995a). Groundwater elevation data indicate that groundwater present in the perched zone follows a convergent pattern of flow oriented in a northeastern to southwestern direction. Groundwater in the perched zone is from I-75 along the western property boundary to the southeast towards the former Air Force Plant 36. The groundwater flow in the upper sand and gravel aquifer is generally towards the southwest. Finally, the groundwater flow in the lower sand and gravel aquifer is to the south-southwest, consistent with the regional flow pattern which parallels the trend of Mill Creek Valley (OBG, 1995a).

3.2.4 Regional Water Resources

Active municipal well fields operated by the Villages of Lockland and Glendale are located only to the north of the GE facility and are located hydraulically upgradient (based on site and regional hydrology) (OBG, 1995a). Two well fields near the site are owned and operated by the Village of Lockland. One well field is approximately 2 miles north of the facility and the other is approximately 3,500 feet to the southwest (OBG, 1995a). Wells 5,6,7 and 8 are located in the well field north of the facility and are currently in operation. Well 4 is located southwest of the facility near the Village of Lockland Water Treatment Plant and is closed. Several wells approximately 1.5 miles north of the facility are also operated by the Village of Glendale (OBG, 1995a). An inactive municipal water well field formerly operated by the City of Reading Water Department is located along Mill Creek to the southeast of the GE plant and was closed in 1993 (OBG, 1995a). The City of Reading now receives water from the City of Cincinnati which receives its water from the Ohio River (OBG, 1995a). All off-site water usage at downgradient locations (hydrologically) utilize the City of Cincinnati water supply.

GE currently obtains process water from the Southwest Ohio Water Company (a private supplier with wells located several miles west of the facility. GE has 6 on-site wells that are used for cooling water and other industrial purposes and three wells are currently active (OBG, 1995a). GE currently obtains drinking water from the City of Cincinnati.

3.3 <u>Zoning Regulations</u>

3.3.1 Introduction

The GE Aircraft Engines facility is located in the Village of Evendale. The study area (*i.e.*, a 1-mile radius from the borders of the GE facility) encompasses additional land in the Villages of Glendale, Lockland, and Woodlawn and in the Cities of Lincoln Heights, Reading, Sharonville, and Wyoming (Figure 3-1). The current zoning regulations and maps were reviewed for each of these communities to characterize land use designations in the study area (Evendale, 1995, 1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993, 1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b). Zoning maps for each community are presented in Attachment A.

Each community has adopted a zoning code (Villages of Glendale and Lockland, and the Cities of Wyoming and Lincoln Heights) or ordinance (Villages of Evendale and Woodlawn, and the Cities of Reading and Sharonville), independently of the others.

3.3.2 Zoning Designations

For ease of discussion, zoning designations were grouped, when applicable, into general categories. For example, several specific "residential" zoning designations are used by communities throughout the study area (*e.g.*, residential, low-density residential, and high-density residential) but these were consolidated under the general category of "residential" for analysis purposes. Four zoning designations were utilized to describe land use for the study area: commercial, open space/public and institutional land, industrial, and residential (Figure 3-3). Although each of the more specific zoning designations which make up a general category allow for slightly different uses, these subtle differences do not impair the overall usefulness of the four zoning designations. The zoning designations that are relevant for each community within the study area are defined below (Figure 3-3).

<u>Village of Evendale</u>

> *Commercial* - established to provide for uses such as office buildings, research use, local and general businesses including retail sales, wholesales, personal services (beauty shops, etc.), repair services, restaurants, hotels/motels, and recreational services. Most business areas in the Village of Evendale are located along major thoroughfares, particularly on Reading Road.
>
> *Industrial* - includes land zoned for manufacturing (cutting, forging, stamping, welding, etc.), grain and cement storage elevators, production of textiles and clothing, printing, binding, collating printed material, and baking and food cooking. The portion of the study area which is located in the Village of Evendale is primarily designated as industrial/commercial and includes the GE facility.

Residential - includes single-family residential uses. Conditional uses under this designation include: schools, parks, playgrounds, churches, cemeteries, and general farming.

Open space/public and institutional land - buildings and land in this designation are used for the following: government buildings, churches, libraries, museums, public and private schools, parks, recreational fields, wildlife areas, hospitals, and nonresidential health and child care centers.

Village of Glendale

Residential - allows single- and double-family dwellings, parks, churches, public schools, educational and other institutions, clubs, and certain other unusual uses by special permit. The portion of the Village of Glendale located in the study area is completely zoned for residential purposes.

City of Lincoln Heights

Commercial - established to provide for uses such as parking, office buildings, local and general businesses including retail sales, personal services (beauty shops, etc.), and restaurants. Most business areas in the City of Lincoln Heights are located along Anthony Wayne Avenue and Mangham Drive (near I-75).

Industrial - includes land zoned for warehousing, truck terminals, agriculture (nurseries, greenhouses, etc.), storage (coal, gas, explosives, grain, etc.), general services or wholesale establishments (offices, building materials or contractors' yards, wholesale produce or meat markets) and manufacturing establishments (machinery, plastic and rubber products, metal finishing, fertilizers, etc.) establishments.

Residential - includes single-, double-, and multi-family residential uses. Special exception uses under this designation include: churches, libraries, museums, medical offices, community centers, and public utilities. The majority of the City of Lincoln Heights is zoned for residential purposes.

Open space/public and institutional land - intended to identify and preserve public and institutional lands and open spaces. Uses under this zoning designation include public parks, playgrounds, recreational areas, public elementary and secondary schools, and municipal services buildings.

Village of Lockland

Commercial - allows for retail sales, service facilities, business and professional offices, motels, banks and other financial institutions, restaurants, theaters, funeral homes, and commercial greenhouses and mortuaries. Conditionally permitted uses include animal hospitals and kennel services, laundromats and dry cleaning services, automobile service stations, and automobile repair garages.

Industrial - permitted uses include industrial and manufacturing, agricultural storage yards, building material yards, warehousing, and wholesaling. Conditionally permitted uses include automobile repair garages, automobile service stations, junkyards, and automobile wreck yards.

Residential - consists of single-, double-, and multi-family dwellings, churches, schools, parklands, public facilities and open spaces.

Open space/public and institutional land - permitted uses include parklands and open spaces, public buildings and facilities, and schools.

City of Reading

Commercial - allows for retail stores, offices, personal services (*i.e.*, barber shops), child day care centers, community centers, banks, animal hospitals and kennels, restaurants, outdoor commercial recreation, publicly-owned garages and service yards, and single- and multi-family dwellings as permitted in the residential districts.

Industrial - permitted principal uses include fabricating, assembling, machining, finishing, and storing of various products (*i.e.*, acid, alcohol, asphalt, carbon, foods, chemicals, etc.).

Residential - consists of single-, double-, and multi-family dwellings, boarding/lodging houses, tourist homes/bed and breakfast homes, and family day care homes. Conditional principal uses include convents, monasteries and membership clubs.

Open space public and institutional land - includes open space/public and institutional land and buildings owned by a unit of government including city hall, administration and municipal buildings, police and fire stations, parks, playgrounds, city/county/ state garage and work yards, public recreation buildings and city-owned utilities. This designation also includes institutional lands and buildings such as public and private schools, electric, gas, telephone, water and sewer utilities, cemeteries, hospitals and churches.

City of Sharonville

Commercial - allows for office buildings and offices, retail stores, personal services (*i.e.*, beauty and barber shops), repair services, motel and hotel accommodations, amusement and recreational services. The portion of the City of Sharonville located in the study area is primarily zoned for commercial purposes.

Industrial - includes offices, research laboratories and production uses (cutting, forging, casting, blending and packaging of chemicals, making of metal alloy products, etc.), and general warehouse and storage facilities.

Residential - consists of single-, double-, and multi-family dwellings, apartment complexes, and agricultural land and buildings. Conditional uses include temporary buildings and fraternal organizations and private clubs.

Open space/public and institutional land - permitted buildings and uses include government (municipal, county, state and federal buildings), civic (churches, libraries, cemeteries, etc.), educational, welfare (hospitals, health centers, child and elderly care, etc.), recreational (parks, playgrounds, public gardens, golf courses, etc.), and public utility facilities. The portion of the City of Sharonville located in the study area with this zoning designation includes Princeton Junior and High Schools.

Village of Woodlawn

Industrial - principal permitted uses include storage and process warehouses, gasoline filling stations, professional research office uses, light industrial (uses which do not produce objectionable odors, smoke, cinders or flash, etc.). The portion of the Village of Woodlawn located in the study area is primarily zoned for industrial purposes.

Residential - consists of a mixture of residential uses including single- and multi-family dwellings as well as institutional, public, and recreational uses. The remaining portion of the Village of Woodlawn located in the study area is zoned for residential purposes.

City of Wyoming

Commercial - includes areas which consist of retail shops, hotels or boarding houses, professional offices, public buildings, theaters, assembly halls, restaurants, public garages, filling stations and automobile repair shops.

Industrial - zoning ordinances for industrial use in the City of Wyoming are not available (Terry Vanderman, Building Inspector, personal communication, 1996). It should be noted that only a small area located on the corner of Wyoming Avenue and Springfield Road is zoned for industrial use and is located within the study area.

Residential - contains single-, double-, and multi-family residences, municipally-owned or operated parks and playgrounds, and churches. The portion of the City of Wyoming located in the study area is primarily zoned for residential use.

Open space/public and institutional land - permitted uses include parklands and open spaces, public buildings and facilities, and schools.

3.3.3 Summary

Zoning designations within the study area included four designations: (1) residential, (2) commercial, (3) industrial, and (4) open space and public/institutional land. The GE facility is largely surrounded by industrial and commercial parcels of land. From the southern portion of the GE facility to the extreme northern portion of the study area, land usage has been zoned for industrial and commercial. Residential communities exist westward from the facility on the opposite side of Highway 75. The nearest residential zone west of the facility is located approximately 0.2 miles in the City of Lincoln Heights. The nearest residential zone east of the facility is located approximately 0.75 miles in the Village of Evendale. The nearest residential zone south of the facility is located approximately 0.1 miles in the Village of Lockland. No residential zones within the study area exist north of the facility and east of Highway 75.

3.4 Demographics

1990 Census Data
Detailed demographic information for each community located within the study area is discussed below and summarized in Table 3-1 (USDC, 1991; 1992a). Summary data for the entire U.S. population are provided in Table 3-2 for comparison purposes (USDC, 1992b; 1993). The study area includes portions of 10 census tracts and the entire portion of census tract 227. The census tracts that comprised the study area included: 224, 225, 226, 227, 228, 229, 230.01, 230.02, 231, 232.01, and 232.02 (Figure 3-5). Demographic information for each of these census tracts is presented in Table 3-3 (USDC, 1991; 1992a).

Evendale
Evendale is located entirely within census tract 231. Demographic information for Evendale (within census tract 231) is summarized in Table 3-3. Demographic information for the Village of Evendale is summarized below and in Table 3-1.

The total population of Evendale was 3,175 in 1990 with a median age of 36 years. Approximately 8% of the population is under five years of age and 8% is 65 years old or older. Based upon these distributions, Evendale has a slightly higher percentage of the population under 5 years of age when compared to the national distribution (7%) and a lower percentage of older residents when compared to the national distribution (13%) (Table 3-2). Evendale has an unemployment rate of only 1%, which is considerably lower than the national unemployment rate (6.3%), and approximately 49% of the population is employed (age 16 and older).

Evendale has no multi-family dwellings and the lowest percentage of rental units (3%) when compared to other communities in the study area. The median housing value ($146,800) and the median rent ($475) in Evendale are among the highest when compared to other communities in the study area and considerably higher than the national values for median housing value ($79,100) and median rent ($374). Approximately 47% of the population has a college education and the median income ($68,450) is the highest in the study area and more than double the national median income ($30,056). Nearly all residents are serviced by public water (100%) and sewer (97%) systems.

Glendale
The portion of Glendale located within the study area is located entirely in census tract 224. However, only a small portion of census tract 224 is located within the study area. Demographic information for Glendale (within census tract 224) is summarized in Table 3-3. Demographic information for the Village of Glendale is summarized below and in Table 3-1.

The total population of Glendale was 2,445 in 1990 with a median age of 41 years. Approximately 5% of the population is under five years of age and 19% is 65 years old or older. Based upon these distributions, Glendale has a lower percentage of the population under 5 years of age and a higher percentage of older residents when compared to the national distributions. Glendale has an unemployment rate of 3%, which is considerably lower than the national unemployment rate, and approximately 49% of the population is employed (age 16 and older).

The percentages of multi-family dwellings (11%) and rental units (18%) in Glendale are among the lowest when compared to other communities in the study area. The median housing value in Glendale ($117,100) is among the highest when compared to other communities in the study area and considerably higher than the national value. Approximately 42% of the population has a college education and the median income ($42,721) is among the highest in the study area and considerably higher than the national median income. Nearly all residents are serviced by public water (99.8%) and sewer (99%) systems.

<u>Lincoln Heights</u>
Lincoln Heights is located entirely within census tract 227. Demographic information for Lincoln Heights (within census tract 227) is summarized in Table 3-3. Demographic information for the City of Lincoln Heights is summarized below and in Table 3-1.

The total population of Lincoln Heights was 4,805 in 1990 with a median age of 30 years. Approximately 9% of the population is under five years of age and 15% is 65 years old or older. Based upon these distributions, Lincoln Heights has a higher percentage of the population under 5 years of age and a higher percentage of older residents when compared to the national distributions. Lincoln Heights has an unemployment rate of 14%, which is the highest in the study area and more than double the national unemployment rate, and the lowest percentage of the population that is employed (age 16 and older) (31%).

The percentages of multi-family dwellings (51%) and rental units (62%) in Lincoln Heights are the highest when compared to other communities in the study area. The median housing value in Lincoln Heights ($40,300) is the lowest in the study area and almost half the national value. Only 4% of the population has a college education and the median income ($14,698) is the lowest in the study area and less than half the national median income. Nearly all residents are serviced by public water (100%) and sewer (99.4%) systems.

<u>Lockland</u>
Lockland is located entirely within census tract 228. Demographic information for Lockland (within census tract 228) is summarized in Table 3-3. Demographic information for the Village of Lockland is summarized below and in Table 3-1.

The total population of Lockland was 4,357 in 1990 with a median age of 32 years. Approximately 9% of the population is under five years of age and 14% is 65 years old or older. Based upon these distributions, Lockland has a higher percentage of the population under 5 years of age and a slightly higher percentage of older residents when compared to the national distributions. Lockland has an unemployment rate of 9.2%, which is higher than the national unemployment rate, and approximately 47% of the population is employed (age 16 and older).

The percentages of multi-family dwellings (50%) and rental units (58%) in Lockland are among the highest when compared to other communities in the study area. The median housing value in Lockland ($51,900) is among the lower values when compared to other communities in the study area and considerably lower than the national value. Only 6% of the population has a college education and the median income ($19,730) is among the lowest in the study area and considerably less than the national median income. Nearly all residents are serviced by public water (100%) and sewer (99%) systems.

Reading

The portion of Reading located within the study area spans two census tracts, including 232.01 and 232.02. Demographic information for Reading (within these census tracts) is summarized in Table 3-3. Demographic information for the City of Reading is summarized below and in Table 3-1.

The total population of Reading was 12,038 in 1990 with a median age of 34 years. Approximately 7% of the population is under five years of age and 14% is 65 years old or older. This age distribution generally reflects the national distribution. Reading has an unemployment rate of 4.9%, which is lower than the national unemployment rate, and approximately 51% of the population is employed (age 16 and older).

Approximately 36% of the dwellings in Reading are multi-family dwellings and 40% are rental units. The median housing value in Reading is $67,200, which is lower than the national value. Approximately 15% of the population has a college education and the median income ($29,647) is one of the lower values in the study area but comparable to the national median income. Nearly all residents are serviced by public water (100%) and sewer (99.6%) systems.

Sharonville

The portion of Sharonville located within the study area spans two census tracts, including 230.01 and 230.02. However, only a small portion of these census tracts are located within the study area. Demographic information for Sharonville (within these census tracts) is summarized in Table 3-3. Demographic information for the City of Sharonville is summarized below and in Table 3-1.

The total population of Sharonville was 11,312 in 1990 with a median age of 35 years. Approximately 6% of the population is under five years of age and 12% is 65 years old or older. This age distribution generally reflects the national distribution. Sharonville has an unemployment rate of 2.3%, which is less than half the national unemployment rate, and approximately 55% of the population is employed (age 16 and older).

Approximately 33% of the dwellings in Sharonville are multi-family dwellings and 38% are rental units. The median housing value in Sharonville ($81,800) is slightly higher than the national value. Approximately 22% of the population has a college education and the median income ($36,332) is higher than the national median income. Nearly all residents are serviced by public water (100%) and sewer (96%) systems.

Woodlawn

Woodlawn is located entirely within census tract 225. Demographic information for Woodlawn (within census tract 225) is summarized in Table 3-3. Demographic information for the Village of Woodlawn is summarized below and in Table 3-1.

The total population of Woodlawn was 2,674 in 1990 with a median age of 33 years. Approximately 6% of the population is under five years of age and 13% is 65 years old or older. This age distribution generally reflects the national distribution. Woodlawn has an unemployment rate of 7.5%, which is higher than the national unemployment rate and approximately 47% of the population is employed (age 16 and older).

Approximately 29% of the dwellings in Woodlawn are multi-family dwellings and 33% are rental units. The median housing value in Woodlawn ($53,900) is lower than the national value. Approximately 18% of the population has a college education and the median income ($31,698) is slightly higher than the national median income. Nearly all residents are serviced by public water (100%) and sewer (93%) systems.

Wyoming

The portion of Wyoming located within the study area is located entirely within census tract 226. However, only a small portion of the city is located within the study area. Demographic information for Wyoming (within census tract 226) is summarized in Table 3-3. Demographic information for the City of Wyoming is summarized below and in Table 3-1.

The total population of the Wyoming was 8,128 in 1990 with a median age of 40 years. Approximately 7% of the population is under five years of age and 14.5% is 65 years old or older. This age distribution generally reflects the national distribution. Wyoming has an unemployment rate of 4.6%, which is lower than the national unemployment rate, and approximately 48% of the population is employed (age 16 and older).

Approximately 16% of the dwellings in Wyoming are multi-family dwellings and 16% are rental units. The median housing value in Wyoming ($140,400) is among the highest when compared to other communities in the study area and considerably higher than the national value. Approximately 60% of the population has a college education and the median income ($58,784) is among the highest in the study area and almost double the national median income. Nearly all residents are serviced by public water (100%) and sewer (99%) systems.

3.5 Characterization of Land Use and Population Activities

The purpose of this section is to identify current land use, characterize general human activities, and identify potentially sensitive subpopulations within the study area. Current land use and population information were researched and confirmed through several sources of information:

(1) local zoning regulations and maps (Evendale, 1995, 1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993, 1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b);

(2) field reconnaissance conducted by ChemRisk® to verify land use;

(3) aerial photographs (AIC, 1994);

(4) land development plans;

(5) the Greater Cincinnati Bell telephone directory; and

(6) Community guides (Evendale, 1996; Sharonville, 1996; and Wyoming, 1996).

3.5.1 Determination of Current Land Use

The study area encompasses both urban and rural characteristics within the communities of Evendale, Glendale, Lincoln Heights, Lockland, Reading, Sharonville, Woodlawn, and Wyoming in northwest Hamilton County, Ohio. The study area (approximately 7.24 square miles) consists of four major current land use designations including:

- industrial/commercial areas;
- residential areas;
- forest, field, and wetland areas; and
- agricultural areas (Figure 3-4).

In addition to these primary land use designations, several other minor designations are relevant to the study area including educational, communal, and recreational. The current land use designations used throughout this section may or may not match zoning designations and are defined below.

Industrial/Commercial Areas includes land developed for commercial or industrial uses as defined by local zoning regulations (Evendale, 1995,1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993,1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b).

Residential Areas include areas which support single-, double- and multi-family dwellings as defined by local zoning regulations (Evendale, 1995,1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993,1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b).

Forest/Field/Wetland Areas

- **Field Areas** include those lands that are currently dominated by herbaceous vegetation with intermittent shrubs, saplings and small trees.

- **Forest Areas** include areas dominated by a continuous community of woody vegetation (trees).

- **Wetland Areas** include areas that exhibit characteristics specific to wetlands as defined by the U.S. Army Corps of Engineers (USCOE). The areas designated as wetlands have not been formally delineated as jurisdictional wetlands and may or may not meet all of the USCOE requirements for jurisdictional wetlands. The USCOE defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (USCOE, 1987).

Agricultural Areas include cultivated and fallow parcels of land as well as land used for nurseries and greenhouses (Evendale, 1995,1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993, 1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b).

Educational Areas include areas used for schools and day care centers.

Communal Areas include areas used for community gatherings and/or for the public good. Such areas include churches, libraries, city administration centers, police and fire stations, etc.

Recreational Areas include areas used for outdoor recreational activities (*e.g.*, parks, golf courses, driving ranges).

Industrial/Commercial Areas

Approximately 48 % of the land within the study area is currently industrial/commercial land. As shown in Figure 3-4, the majority of land actively used for industrial or commercial purposes is located within the Village of Evendale surrounding and including the GE facility.

The GE facility is located on approximately 400 acres of land in Evendale, Ohio. The industrial facility is bordered by Interstate Route 75 to the west, Conrail railroad tracks to the east, Glendale-Milford Road (Route 126) to the north, and Shepherd Lane to the south.

Several non-GE industrial properties are located to the east of GE including:

- Formica Industries
- Cavett asphalt plant (formerly Darling Rendering)
- Cincinnati Drum
- Morton International Incorporated
- Pristine Incorporated (Superfund Site)
- The City of Reading's former municipal landfill, incinerator and ash fields

Cincinnati Drum is an active facility providing cleaning, reclamation, and recycling of steel drums (OBG, 1995a). Morton International manufactures synthetic stabilizers and plasticizers. Pristine, Inc.

operated as a liquid waste disposal unit until operations were ceased in 1981 when the site was added to the USEPA National Priorities List in December 1982. The Record of Decision for the Pristine, Inc. site was issued in 1988 and amended in 1990. The remedial actions proposed for the three-acre site include decontamination of structures, mobile on-site thermal treatment of soils and sediments, *in situ* soil vapor extraction and ground water extraction and treatment. The contaminants of concern at the Pristine site include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and pesticides (OBG, 1995a). Both the active Cincinnati Drum and inactive Pristine, Inc. occupy the location of the former International Minerals Corporation plant which manufactured sulfuric acid and fertilizers (OBG, 1995a).

Additionally, the GE facility is bordered by municipal waste recycling operation to the north and various commercial and industrial businesses to the west.

Residential Areas

Approximately 20 % of the land within the study area is currently residential property. As shown in Figure 3-4, the Village of Lockland and the Cities of Lincoln Heights and Reading have the largest residential areas within the study area. Residential uses consist of single-, double-, and multi-family dwellings, with the highest percentage of double- and multi-family dwellings occurring in the City of Lincoln Heights (Section 3.4). The closest residential areas to the GE boundary are located to the west and south of the site. Residential areas near GE boundaries include:

- residential areas approximately .39 miles and .04 miles west of I-75 and the GE boundaries in the Village of Woodlawn and the City of Lincoln Heights, respectively;
- a residential area approximately .18 miles southeast of the GE facility in the City of Reading;
- a residential area approximately 0.6 miles southwest of the GE facility in the Village of Lockland;
- a residential area approximately 0.6 miles east of GE and the other industrial companies listed above in the Village of Evendale;
- a residential area approximately 1.2 miles northeast of GE in the City of Sharonville; and
- a residential area approximately 1.7 miles northwest of the GE boundaries and west of I-75 in the Village of Glendale.

One residence within the GE property boundary is owned by GE and leased to a farmer by GE on a yearly basis.

Forest/Field/Wetland Areas

Approximately 23% of the study area is currently undeveloped (*i.e.*, forests, fields and wetlands) (Figure 3-4).

Agricultural Areas

About 2% of the land within the study area is currently used for agricultural purposes. A total of 3 plots of land used for agricultural purposes were identified in the study area. One agricultural field is located east of the site and can be seen from Glendale - Milford Road. A second agricultural field is located on a plot of land stretching north from Cooper Road between two residential neighborhoods and is associated with a historic working farm open to the public with access from Reading Road. A third agricultural field is leased by a farmer from GE and is located on GE facility property between Formica Inc. and GE. GE can terminate this property lease on a yearly basis if desired (OBG, 1995a). The major crops produced in Hamilton County are corn, soybeans, hay, and nursery/horticulture crops and the average farm size is approximately 115 acres (Ohio Department of Agriculture, 1995).

Educational Areas

A total of 16 schools and child care facilities are located within the one-mile study area in the Villages of Evendale, Glendale, Lockland, and Woodlawn, and the Cities of Lincoln Heights, Reading, Sharonville, and Wyoming (Table 3-4). This includes one school for the deaf ranging from newborn to 12th grade, one home for the handicapped (newborn through 35 years), one youth academy for children 6 weeks to 12 years, 4 pre-schools/ day care centers or head start programs, 12 elementary/middle schools, 5 junior/senior high schools, and one college.

Communal Areas

Communal areas include areas where a large number of people gather for various reasons and activities (*e.g.*, community centers, libraries, churches). Also included in this category are areas used for the public good such as community administration centers and police and fire stations (Figure 3-4). Communal areas within the study area were identified based upon limited site reconnaissance, Greater Cincinnati Bell telephone directory, and Cincinnati street maps. Communal areas within the study area include:

- 8 police/fire stations;
- 4 city halls/administration centers/community centers; and
- approximately 40 churches and libraries.

Municipal buildings including police/fire stations, city halls/administration centers for the Villages of Evendale and Lockland and the Cities of Lincoln Heights and Reading all are located within the study area. Municipal complexes for the four remaining communities (Villages of Glendale and Woodlawn and the Cities of Sharonville and Wyoming) are located outside the study area boundary.

Recreational Areas

Approximately 4% of the land within the study area is currently used for outdoor recreational activities. There are a total of 19 parks located within the study area (Figure 3-4). Fifteen of these are neighborhood parks in the Village of Lockland and the Cities of Reading, and Wyoming. The two remaining recreational areas are miniature golf courses and driving ranges in Evendale and Sharonville.

3.5.2 Human Activities Associated with Identified Land Uses

This section provides a general overview of the human activities associated with each land use category identified in Section 3.5.1. As indicated in *RAGS, Part A*, the following represents a "common sense" evaluation based upon a general understanding of the types of activities one might expect under the identified land use categories (USEPA, 1989a). When possible, site-specific information is provided.

Human activities and activity patterns within the study area were characterized using local demographic information, site visits and population growth estimates obtained from the USDC and the Bureau of the Census (1991; 1992a,b; 1993).

3.5.2.1 Industrial/Commercial Areas

GE Property

As described in Section 3.5.1, the majority of the GE facility is located in the Village of Evendale and is industrial in nature. Approximately 6,000 employees work on-site in production, managerial, maintenance, and administrative staff positions. Facility operations occur during three shifts daily with the majority of employees working the first shift. The majority of managerial and administrative work is done indoors during a normal 8 hour workday and 40-hour workweek. Some maintenance work is performed outdoors. Thus, human activities performed at the GE facility are expected to involve indoor and outdoor work during a normal 8-hour work day and 40-hour work week.

Non-GE Property

As described in Section 3.5.1, several industrial and commercial properties exist within the study area. The majority of these businesses are commercial in nature (*e.g.*, machine shops, dry cleaners, auto repair shops, etc.). Thus, much of the non-GE commercial/industrial activity in the study area is expected to involve indoor work during a normal 8-hour workday and 40-hour workweek.

3.5.2.2 Residential Areas

As discussed in Section 3.5.1, residential areas exist throughout the study area with denser concentrations in the Cities of Lincoln Heights and Reading and the Village of Lockland. The activity patterns associated with residential areas is likely to vary widely. As summarized in the *Exposure Factors Handbook* (USEPA, 1989b), several time use studies have been conducted to determine the amount of time spent in various residential activities as well as time spent at home and away from home. In general, the time spent at home is dependent upon factors such as age, employment status, and health status. For example, one would expect young children (pre-school age) and retired adults to spend more time at home as compared to school age children or working adults. It has been estimated that average adults (men and women) spend approximately 64% of their time (*i.e.*, ≈16 hours/day) at home involved in various activities (USEPA, 1989b). Approximately 2% of this time (*i.e.* ≈0.3 hours/day) is spent outdoors at the place of residence (USEPA, 1989b). As discussed in the *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Parameters* (USEPA, 1991a), residents can be assumed to be present for 350 days per year (assuming a 2-week vacation). Both indoor and outdoor activities would be expected with outdoor activities declining in the winter months.

3.5.2.3 Forest/Field/Wetland Areas

A small portion of the study area within the 1 mile boundary consists of undeveloped land including forests, fields, and wetlands (Figure 3-4). Human activity associated with such land is likely to be limited to recreational activities such as hiking, nature observation, etc. These areas may be visited by local youths for the purposes of play. The percent of time involved in such activities is likely to be highly variable and dependent upon seasonal conditions.

3.5.2.4 Agricultural Areas

A small amount of property within the study area is devoted to agricultural production (approximately 2%). As mentioned in Section 3.5.1, the major crops produced in Hamilton County are corn, soybeans, hay, and nursery/horticulture crops and the average farm size is approximately 115 acres (Ohio Department of Agriculture, 1995). Thus, activities associated with the production of such crops is expected to be seasonal (spring, summer, and fall) and primarily associated with outdoor work during hours of daylight (*i.e.*, 8 to 14 hours/day). Three agricultural plots have been identified in the study area and are all located in the Village of Evendale (Section 3.5.1).

3.5.2.5 Educational Areas

A number of schools exist within the study area including day cares/pre-schools, elementary and grade schools, and intermediate and secondary schools (Table 3-4). The amount of time spent in these areas by school-age children is expected to vary between 6 and 10 hours per day for approximately 178 days per year (USDC, 1992c). The majority of the activities are expected to occur indoors with the limited outdoor activities (recess, sports, etc.) declining in the winter months.

3.5.2.6 Communal Areas

Activities associated with communal areas (churches, libraries, etc.) are expected to occur primarily indoors with the percent of time spent in the area varying according to the activity.

3.5.2.7 Recreational Areas

A number of recreational areas exist within the study area including parks and mini golf courses (Figure 3-4; Table 3-5). All of the activities associated with these areas are expected to occur outdoors and are primarily limited to fair weather conditions (*i.e.*, dry, warm weather). The percent of time involved in the various possible recreational activities is expected to vary widely.

3.5.3 Identification of Potentially Sensitive Subpopulations

The purpose of this section is to identify subpopulations within the study area which may be considered sensitive based on age and activity patterns. Typical subpopulations which fall into this category include:

- those with increased sensitivity;
- those with behavior patterns that may result in high exposure; and

- those with current or past occupational exposures to chemical sources other than the site (USEPA, 1989a).

Subpopulations which may be more susceptible to anthropogenic substances include the young (*i.e.*, infants and children), the elderly, pregnant or nursing women, and people with chronic illnesses (USEPA, 1989a). Potentially sensitive subpopulations associated with schools, day care centers, hospitals, nursing homes, and active recreational lands were identified within the study area. The subpopulations were identified based on field reconnaissance conducted by ChemRisk® personnel and other sources (Hamilton County street map; the Village of Evendale Recreational Guide; the City of Sharonville Municipal Services Guide; the City of Wyoming Community Guide; and the Greater Cincinnati Bell telephone directory) and are graphically summarized in Figure 3-5. There are a total of 16 schools and day care centers (Table 3-4) and 2 nursing homes (Table 3-6) within the study area (Figure 3-5). Recreational lands include two miniature golf courses and driving ranges, and 19 parks (Table 3-5). The approximate location and distance from the facility for a few examples of potentially sensitive subpopulations is presented below.

Subpopulation Type	Name	Location	Distance from Facility
Children	St. Rita's School for the Deaf	northwest of GE	0.08 miles
Recreators	Koenig Park	south of GE	0.13 miles
Elderly	Lindy Manor Nursing Home	west of GE	0.27 miles

3.5.4 Prevailing Wind Direction and Associated Populations

As mentioned in Section 3.2, the prevailing wind direction for the study area is from the south/southwest (National Climatic Data Center, 1995). Thus, populations located north/northeast of GE property represent potential receptors for airborne chemicals which may be released from the site. From Figures 3-4 and 3-5, it can be seen that each of the previously discussed land use designations associated with the study area are represented downwind of the site including populations associated with:

- industrial/commercial use;
- residential areas;
- recreational areas; and
- schools and day cares.

3.6 Plausible Future Land Use

The purpose of this section is to evaluate the likelihood of current land use within the study area changing due to population growth, zoning changes, property transactions, and site activities. The determination of plausible future land use for the study area was based upon available information including: (1) current zoning designations, (2) demographics, (4) population growth estimates, (5) established land use trends, and (6) professional judgement, as recommended by *RAGS, Part A* (USEPA, 1989a).

3.6.1 GE-Owned Property

Future land use alternatives for GE-owned property were evaluated. The type of activities and land use for most of these areas are not expected to change significantly in the next several years. If land use modifications are desired in the future, the new use designations will be evaluated with respect to potential environmental risks and altered as necessary. Therefore, it is assumed that future on-site populations will consist of employees working at the GE facility. Due to the regulatory constraints for land use and operations at the site, it is assumed that security of the entire GE facility will be maintained to prevent public access and trespassing by unauthorized persons (OBG, 1995a). It can only be assumed that future land use of the facility will remain as it is today with any modifications undergoing thorough regulatory review and approval (OBG, 1995a).

3.6.2 Non-GE-Owned Property

Since the potential exists for site-related chemicals to be transported to off-site locations, it is important to consider plausible future land uses for areas surrounding the GE site. Each community's officials within the study area were contacted and questioned about future development plans for their municipalities. The Cities of Lincoln Heights, Reading, Sharonville, and Wyoming and the Villages of Glendale, Lockland, and Woodlawn did not have documented future development plans. However, each city official stated that major changes in the current land use were not expected. In addition, the Village of Evendale is the only municipality which has a documented general development plan. Future development plans for the Village of Evendale involve the protection of residential areas from industrial and commercial encroachment and maintenance of current land use designations. Future plans for the Village of Evendale include the development and construction of an industrial parkway northeast of the GE facility with access from Sharon Road. It is assumed that current land use designations will remain the same as present for the Village of Evendale (Evendale, 1995).

Based upon local zoning regulations, a consideration of current land use, projected population growth estimates, future development plans, and personal communication with city officials, the most plausible future uses for the majority of non-GE-owned land within the study area is expected to remain unchanged (Section 3.5). Therefore, off-site land uses are expected to remain as presently zoned (commercial, industrial, and residential).

3.7 Summary

Human populations and current land use were characterized for the GE - Evendale Facility and surrounding area in accordance with the *RFI Work Plan* (OBG, 1995b). The current land use and plausible future land uses within the study area were determined through several sources of information:

(1) local zoning regulations and maps (Evendale, 1995,1989; Glendale, 1996, 1983; Lincoln Heights, 1987a,b; Lockland, 1989a,b; Reading, 1992a,b; Sharonville, 1993,1994; Woodlawn, 1987a,b; and Wyoming, 1995a,b);

(2) field reconnaissance conducted by ChemRisk® on November, 10 and 11, 1996 to verify land use;

(3) aerial photographs (AIC, 1994);

(4) land development plans;

(5) the Greater Cincinnati Bell telephone directory; and

(6) Community guides (Evendale, 1996; Sharonville, 1996; and Wyoming, 1996).

The land use categories that were most applicable and the focus of this study included (1) residential, (2) commercial/industrial, (3) recreational (4) agricultural and (5) forest/field/wetland. The land use within the study area was confirmed during a site visit conducted by ChemRisk® on November 10 and 11, 1996. Future land use was determined by projections from city plans as well as land use plans for GE-owned property.

3.7.1 Identification of Potential Human Receptors

Human populations and activities associated with current and future land uses were identified and described with respect to those characteristics that may influence exposure such as:

- location relative to the site;
- activity patterns; and
- presence of sensitive subpopulations (USEPA, 1989a).

Current land use within the study area was confirmed by reviewing currently available information (*e.g.*, zoning maps, aerial photographs, etc.) and by field reconnaissance. Populations associated with the identified land use were characterized using available demographic information.

The requirements for identifying potential human receptors and the relevant sections of this report are summarized below.

- Identify local uses and possible future uses of groundwater (Section 3.4).

- Present a demographic profile of the people who use or have access to the facility and adjacent land (Section 3.5).

- Identify human use of, or access to, the facility and adjacent lands (Section 3.6).

The study area consists of four major land use designations including:

- industrial/commercial;
- residential areas;
- open land and
- agricultural areas.

Approximately 48% of the study area is in industrial/commercial use. Approximately 20 % of the study area consists of residential areas. GE is directly bordered to the north and east by industrial/commercial property. Interstate route I-75 acts as a physical barrier to the west of the site. The closest residential area is located to the south of the site in the City of Reading. The Cities of Lincoln Heights and Reading and the Village of Lockland have the largest residential areas within the study area. In addition to the above land uses, other notable uses of land within the study area include:

- 16 schools including 5 pre-school/day care centers;
- approximately 52 communal area (e.g., churches, libraries, etc.;
- 2 nursing homes; and
- 19 parks.

The two closest residential neighborhoods are located to the west of the site across I-75 and to the south of the site in the City of Lincoln Heights and the Village of Lockland, respectively. The school closest to the GE boundary is St. Rita's school for the deaf in Evendale located approximately 0.08 miles from the northwest boundary. The park closest to the GE boundary is Koenig Park located approximately 0.13 miles south of the site boundary in the City of Reading. The nearest nursing home is Lindy Manor located approximately 0.27 miles west of the site across I-75 in the City of Lincoln Heights.

3.7.2 Future Land Use

GE-Owned Property

Future land use alternatives for GE-owned property were evaluated. The type of activities and land use for most of these areas are not expected to change significantly in the next several years. If land use modifications are desired in the future, the new use designations will be evaluated with respect to potential environmental risks and altered as necessary. Therefore, it is assumed that future on-site populations will consist of employees working at the GE facility. An on-site worker exposure scenario is the most plausible receptor scenario for GE-owned property. Due to the regulatory constraints for land use and operations at the site, it is assumed that security of the entire GE facility will be maintained to prevent public access and trespassing by unauthorized persons (OBG, 1995b). It can only be assumed that future land use of the facility will remain as it is today with any modifications undergoing thorough regulatory review and approval (OBG, 1995b).

Non-GE-Owned Property

Based upon local zoning regulations, a consideration of current land use, projected population growth estimates, future development plans, and personal communication with city officials, the most plausible future uses for the majority of non-GE-owned land within the study area is expected to remain unchanged (Section 3.6). Therefore, off-site land uses are expected to remain as presently zoned (commercial, industrial, and residential).

3.7.3 Conclusions

Based on the information presented in this section, potential receptors to site-related releases from SWMUs or AOCs are summarized below. The complete exposure pathways that will be evaluated for these population types in the risk assessment are discussed further in the Exposure Assessment (Section 5.0).

Population Type	GE Property (On-Site) Current	GE Property (On-Site) Future	Off-Site Property Current	Off-Site Property Future
Resident	---	---	✓[a]	✓[a]
Worker	✓	✓[b]	✓	✓
Visitor	✓	✓[b]	---	---
Sensitive Subpopulation	---	---	✓[a]	✓[a]

a Populations located to the north / northeast are of primary interest because this is considered downwind of the facility; these populations types are not expected to occur at on-site locations.

b The nature and extent of potential exposure to site-related chemicals will vary for the worker and/or visitor populations. For example, on-site exposures to subsurface soils for current conditions is expected to be minimal or negligible. However, future activities at on-site locations (e.g., excavation, construction) may make subsurface soils an exposure medium.

TABLE 3-1
DEMOGRAPHIC INFORMATION FOR LOCAL COMMUNITIES[a]

	Evendale	Glendale	Lincoln Hts.	Lockland	Reading	Sharonville	Woodlawn	Wyoming
Total Population	3,175	2,445	4,805	4,357	12,038	11,312	2,674	8,128
% Male	50.0	47.0	44.8	47.0	48.4	48.6	47.7	47.8
% Female	50.0	53.0	55.2	53.0	51.6	51.4	52.3	52.2
% Minority	10.4	16.4	99.3	25.1	2.4	3.7	74.4	12.6
Median Age	35.8	41.1	30.1	32.3	33.7	34.7	32.5	39.5
% Under 5	8.0	5.4	9.0	8.9	7.2	6.1	5.6	6.6
% 65 and Over	8.1	18.9	15.1	14.3	14.0	12.2	12.5	14.5
% High School Graduate or Higher	90.2	87.3	51.1	61.6	72.6	80.1	73.0	89.6
% Bachelor's Degree or Higher	46.8	41.9	4.4	5.9	14.6	21.9	17.9	59.3
Employed Persons 16 and Over	1,547	1,186	1,468	2,044	6,162	6,235	1,249	3,868
% of Population Employed	49	49	31	47	51	55	47	48
Unemployment Rate (%)	1.0	3.0	14.2	9.2	4.9	2.3	7.5	4.6
Median Household Income in 1989	$68,450	$42,721	$14,698	$19,730	$29,647	$36,332	$31,698	$58,784
Persons Per Household	3.1	2.6	2.7	2.3	2.4	2.4	2.7	2.6
Housing Units:								
Total Units	1,026	985	1,867	1,975	5,117	5,071	1,109	3,280
1 Unit in Structure	1,026	875	919	978	3,276	3,383	783	2,752
2 to 4 Units in Structure	0	51	328	467	691	263	94	350
5 to 9 Units in Structure	0	37	453	147	283	308	101	50
10 or More Units in Structure	0	22	167	383	867	1,117	131	128
% Multi-family Dwellings	0	11	51	50	36	33	29	16
Occupied Housing Units:								
Total Units	1,001	936	1,733	1,865	4,881	4,737	979	3,162
% Owner-Occupied	97.1	81.6	38.4	42.2	60.5	61.8	67.2	83.7
% Rented	2.9	18.4	61.6	57.8	39.5	38.2	32.8	16.3
Median Housing Value	$146,800	$117,100	$40,300	$51,900	$67,200	$81,800	$53,900	$140,400
Median Rent	$475	$338	$210	$270	$323	$433	$488	$356
% Utilizing Public Water System or Source Other Than an Individual Well	100.0	99.8	100.0	100.0	100.0	100.0	100.0	100.0
% Utilizing Public Sewer	96.9	99.1	99.4	98.9	99.6	96.3	93.1	98.6

a Based on 1990 census data (USDC, 1991; 1992a).

TABLE 3-2
U.S. SUMMARY DEMOGRAPHIC INFORMATION[a]

Total Population	248,709,873
% Male	48.7
% Female	51.3
% Minority	19.7
Median Age	32.9
% Under 5	7.4
% 65 and Over	12.6
% High School Graduate or Higher	75.2
% Bachelor's Degree or Higher	20.3
Employed Persons 16 and Over	115,681,202
% of Population Employed	47
Unemployment Rate (%)	6.3
Median Household Income in 1989	$30,056
Persons Per Household	2.6
Housing Units:	
Total Units	102,263,678
1 Unit in Structure	74,282,661
2 to 4 Units in Structure	9,876,407
5 to 9 Units in Structure	4,935,841
10 or More Units in Structure	13,168,769
% Multi-family Dwellings	27
Occupied Housing Units:	
Total Units	91,947,410
% Owner-Occupied	64.2
% Rented	35.8
Median Housing Value	$79,100
Median Rent	$374
% Utilizing Public Water System or Source Other Than an Individual Well	85.2
% Utilizing Public Sewer	74.8

a Based on 1990 census data (USDC, 1992b; 1993).

TABLE 3-3
DEMOGRAPHIC INFORMATION FOR CENSUS TRACTS IN THE STUDY AREA[a]

	Evendale	Glendale	Lincoln Hts.	Lockland	Reading		Sharonville		Woodlawn	Wyoming
	231	224	227	228	232.01	232.02	230.01	230.02	225	226
Total Population	3,175	2,445	4,805	4,357	3,414	8,605	4,067	5,853	2,674	7,607
% Male	50.0	47.0	44.8	47.0	48.2	48	40.6	48.2	47.7	48
% Female	50.0	53.0	55.2	53.0	51.8	52	59.4	51.8	52.3	52
% Minority	10.4	16.4	99.3	25.1	1.7	3	20.9	2.7	74.4	13
Median Age	35.8	41.1	30.1	32.3	34.4	33.4	34.7	34.6	32.5	38.9
% Under 5	8.0	5.4	9.0	8.9	7.2	7	4.3	6.7	5.6	7
% 65 and Over	8.1	18.9	15.1	14.3	17.9	12.5	14.4	11.3	12.5	14.4
% High School Graduate or Higher	90.2	87.3	51.1	61.6	57.0	78.8	75.5	79.1	73.0	89.3
% Bachelor's Degree or Higher	46.8	41.9	4.4	5.9	5.6	18.2	15.9	19.8	17.9	58.6
Employed Persons 16 and Over	1,547	1,186	1,468	2,044	1633.0	4,529	2,268	2,997	1,249	3,571
% of Population Employed	49	49	31	47	47.8	53	47	51	47	47
Unemployment Rate (%)	1.0	3.0	14.2	9.2	5.7	4.6	3.4	1.3	7.5	5.0
Median Household Income in 1989	$68,450	$42,721	$14,698	$19,730	$25,855	$31,531	$30,582	$38,159	$31,698	$56,665
Persons Per Household	3.1	2.6	2.7	2.3	2.3	2.5	2.1	2.7	2.7	2.6
Housing Units:										
Total Units	1,026	985	1,867	1,975	1,485	3,626	2,066	2,203	1,109	3,037
1 Unit in Structure	1,026	875	919	978	880	2,390	921	1,915	783	2,548
2 to 4 Units in Structure	0	51	328	467	364	327	94	78	94	334
5 to 9 Units in Structure	0	37	453	147	145	138	168	30	101	42
10 or More Units in Structure	0	22	167	383	96	771	883	180	131	113
% Multi-family Dwellings	0	11	51	50	41	34	55	13	29	16
Occupied Housing Units:										
Total Units	1,001	936	1,733	1,865	1,405	3,470	1,868	2,152	979	2,928
% Owner-Occupied	97.1	81.6	38.4	42.2	51.4	64.1	36.3	81.9	67.2	82.8
% Rented	2.9	18.4	61.6	0.0	48.6	35.9	63.7	18.1	32.8	17.2
Median Housing Value	$146,800	$117,100	$40,300	$51,900	$50,500	$71,400	$79,100	$76,600	$53,900	$140,500
Median Rent	$475	$338	$210	$270	$272	$350	$436	$364	$488	$352
% Utilizing Public Water System or Source Other Than an Individual Well	100.0	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% Utilizing Public Sewer	96.9	99.1	99.4	98.9	100.4	99.4	98.4	98.9	93.1	99.3

a Based on 1990 census data (USDC, 1991; 1992a).

TABLE 3-4
SCHOOLS AND CHILD CARE FACILITIES LOCATED WITHIN THE STUDY AREA
(Page 1 of 1)

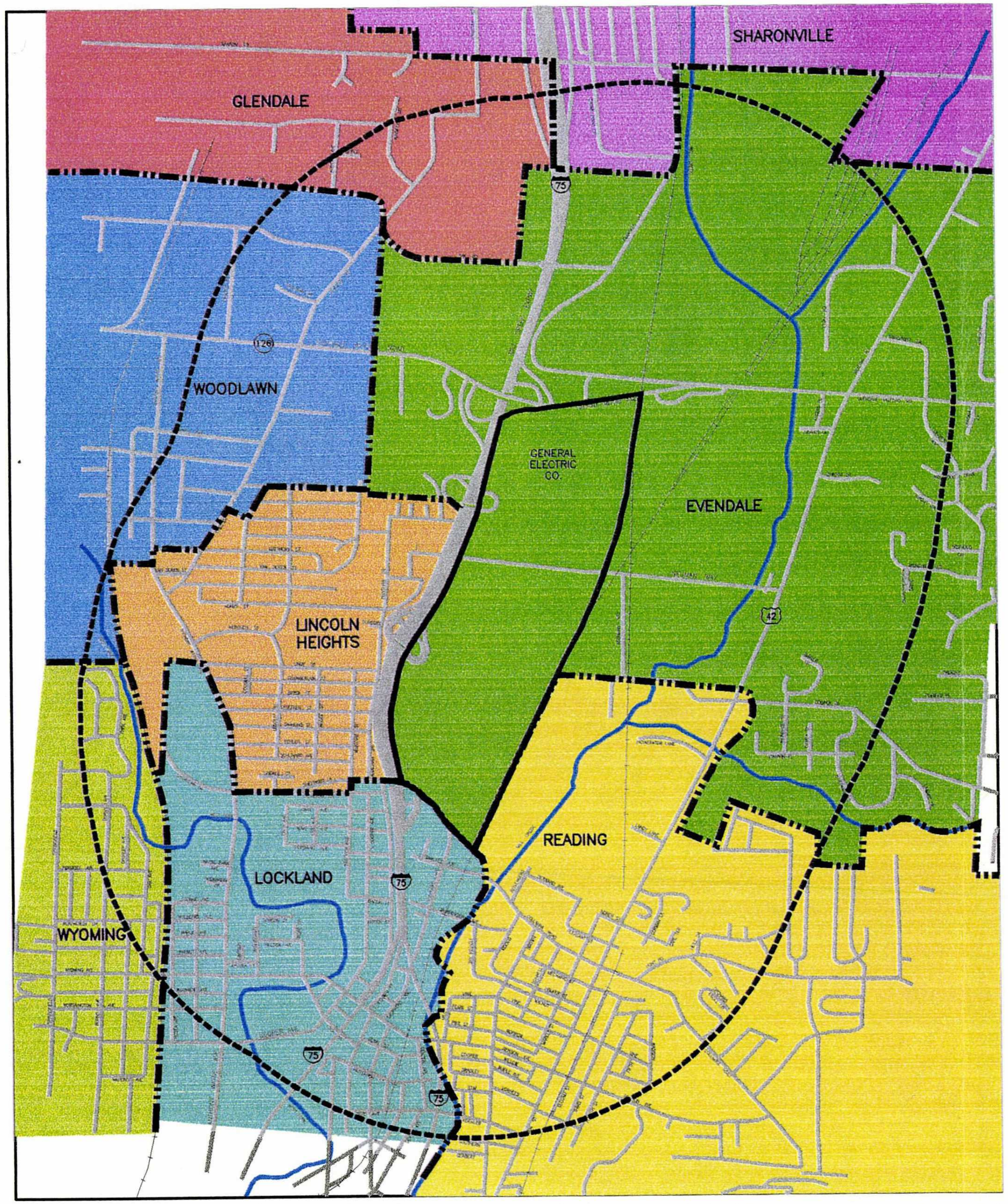
Number on Figure	School	Address	Grades/Ages	Community
S-1	Kids Are Fun	9654 Reading Rd	6 wks - 5 yrs	Evendale
S-2	St Rita School for the Deaf	1720 Glendale-Milford Rd	Newborn - gr 12	Evendale
	Landmark Christian Schools	500 Oak Rd	K - 12	
S-3	Landmark Kiddie Kollege	1600 Glendale-Milford Rd	6 wks - 5 yrs	Glendale
S-4	Bethany School	495 Albion Ave	K - 8	Glendale
	Lincoln Hts Child Care Ctr (Head Start)	1100 Lindy Ave	3 yrs - 5 yrs	
S-5	Smith-Flowers Head Start	1100 Lindy Ave	3 yrs - 5 yrs	Lincoln Hts
S-6	Lincoln Hts Elementary School	1200 Lindy	K - 6	Lincoln Hts
S-7	Lockland Elementary School	200 N Cooper Ave	K - 6	Lockland
S-8	Lockland Middle School	218 N Cooper Ave	7 - 8	Lockland
S-9	Lockland High School	249 W Forrer Ave	9 - 12	Lockland
S-10	Central Elementary School	Bonnell & Halker Aves	K - 6	Reading
S-11	Sts Peter & Paul	416 W Vine	1 - 8	Reading
S-12	Reading Junior Senior High School	810 E Columbia Ave	7 - 12	Reading
S-13	Mt Notre Dame Academy	E Columbia Ave	9 - 12	Reading
S-14	Noah's Ark Christian Academy	2479 Crowne Point Dr	6 wks - K	Sharonville
S-15	Southern Ohio College	1011 Glendale-Milford Rd	College	Woodlawn
S-16	Wyoming High School	106 Pendery Ave	9 - 12	Wyoming

TABLE 3-5
PARKS AND RECREATIONAL FACILITIES LOCATED WITHIN THE STUDY AREA

Number on Figure	Park/Recreational Facility	Address	Community
P-1	Freight Station Park	W Forrer at I-75	Lockland
P-2	Gardner Park	W end of Bacon St	Lockland
P-3	Jonte Park	W end of Jonte Ave at Park Ave	Lockland
P-4	Richardson Park	Wyoming Ave at I-75	Lockland
P-5	Tangeman Park	Wyoming Ave at I-75	Lockland
P-6	Tot Lot	Walnut St	Lockland
P-7	Wayne Park	N Wayne Ave	Lockland
P-8	Centennial Park	North St	Reading
P-9	Flege Park	Flora Ave	Reading
P-10	Haffey Fields	Riesenburg	Reading
P-11	Koenig Park	Koenig Ave	Reading
P-12	Morton Fields	West St	Reading
P-13	Observatory Park	Observatory & Columbia	Reading
P-14	Veteran's Memorial Stadium	West St	Reading
P-15	Vorhees Park	Koehler & Jefferson	Reading
P-16	North Park Field	N Park Ave	Wyoming
P-17	Oak Park/Oak Playground	Oak Ave	Wyoming
P-18	Van Roberts Playground	Van Roberts Pl	Wyoming
G-1	Putt Putt Golf & Games	9941 Reading Rd	Evendale
G-2	Golden Tee Putt Putt & Driving Range	I-75 & Sharon Rd	Sharonville

TABLE 3-6
NURSING HOMES LOCATED WITHIN THE STUDY AREA
(Page 1 of 1)

Number on Figure	Name	Address	Community
N-1	Columbia Health Care Center	Columbia Ave & Reading Rd	Reading
N-2	Lindy Manor Nursing Home	1153 Lindy Ave	Lincoln Heights



N

SCALE

0 1000' 2000' 3000'

LEGEND

- Railroad
- Study Area Boundary
- GEAE Facility Boundary
- Surface Water
- Community Boundary

COMMUNITIES

- Sharonville City
- Village of Evendale
- Reading City
- Village of Lockland
- Wyoming City
- Village of Lincoln Heights
- Village of Glendale
- Village of Woodlawn

G.E. AIRCRAFT ENGINES FACILITY
EVENDALE, OHIO

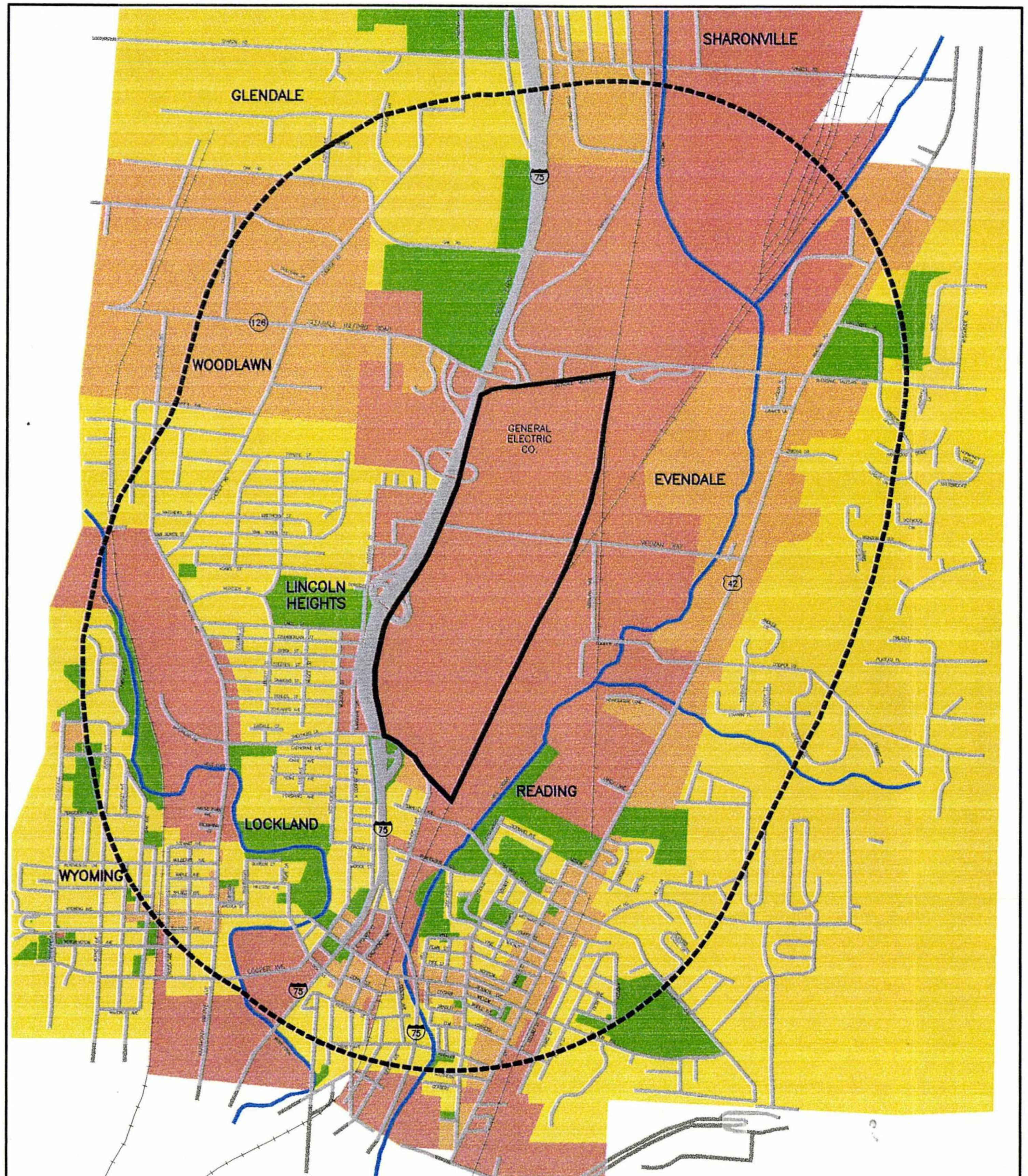
McLaren Hart ENVIRONMENTAL ENGINEERING CORPORATION

DRWN: TML	DATE: 11-96
CHKD	DATE
APPD	DATE
SCALE	AS SHOWN

COMMUNITIES WITHIN THE STUDY AREA

Filename: R:\3673\3673d003.dwg

DRAWING NUMBER FIGURE 3-1



N

SCALE

0 1000' 2000' 3000'

LEGEND

- Railroad
- Study Area Boundary
- GEAE Facility Boundary
- Surface Water

ZONING DESIGNATIONS

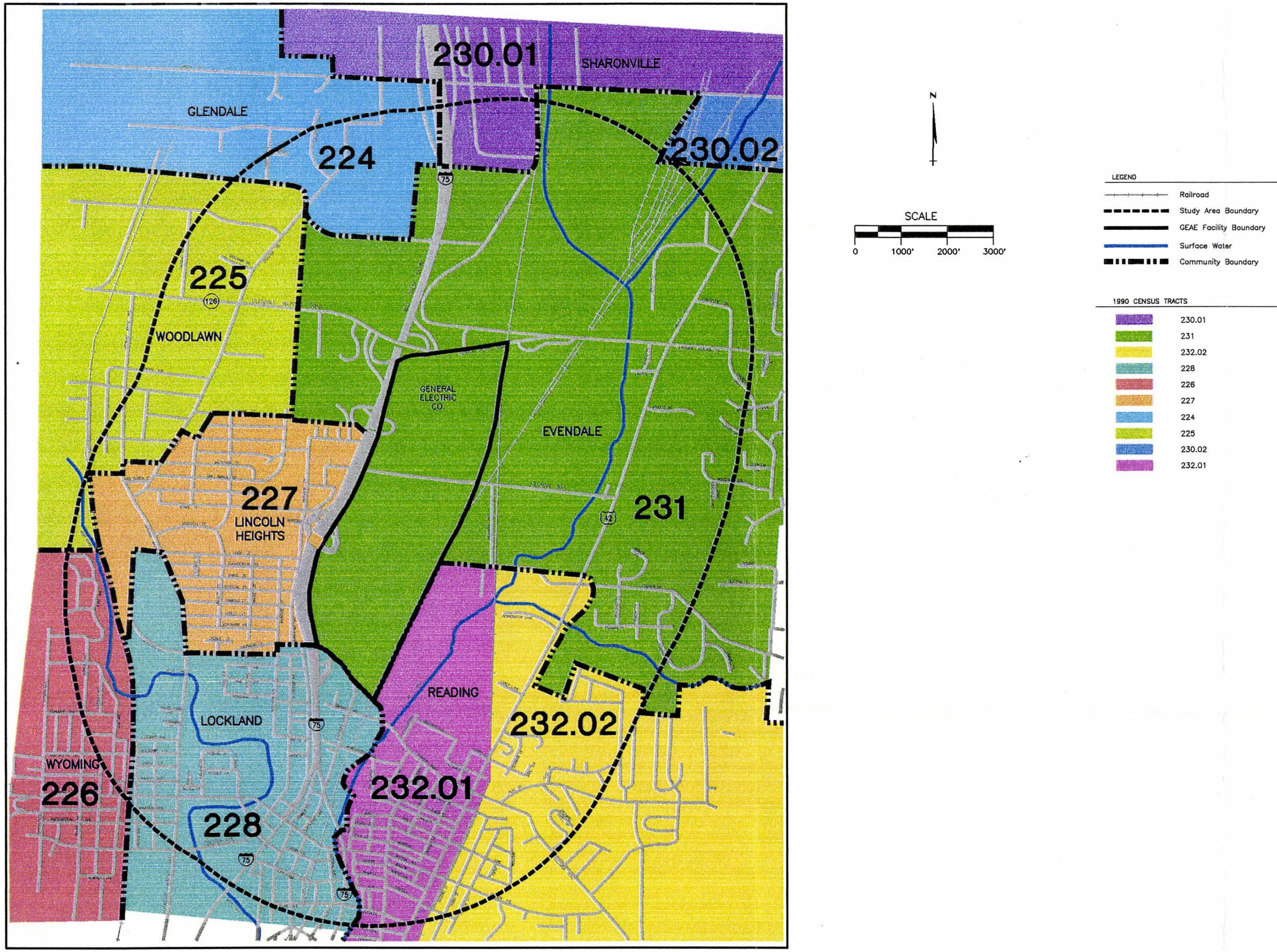
- Residential
- Commercial
- Industrial
- Open Space & Public/Institutional Land

G.E. AIRCRAFT ENGINES FACILITY EVENDALE, OHIO		
McLaren Hart ENVIRONMENTAL ENGINEERING CORPORATION	DRWN: TML	DATE: 11-96
	CHKD	DATE
	APPD	DATE
	SCALE	AS SHOWN

ZONING DESIGNATIONS WITHIN THE STUDY AREA

Filename: R:\3673\3673d004.dwg

DRAWING NUMBER FIGURE 3-2



G.E. AIRCRAFT ENGINES FACILITY
EVENDALE, OHIO

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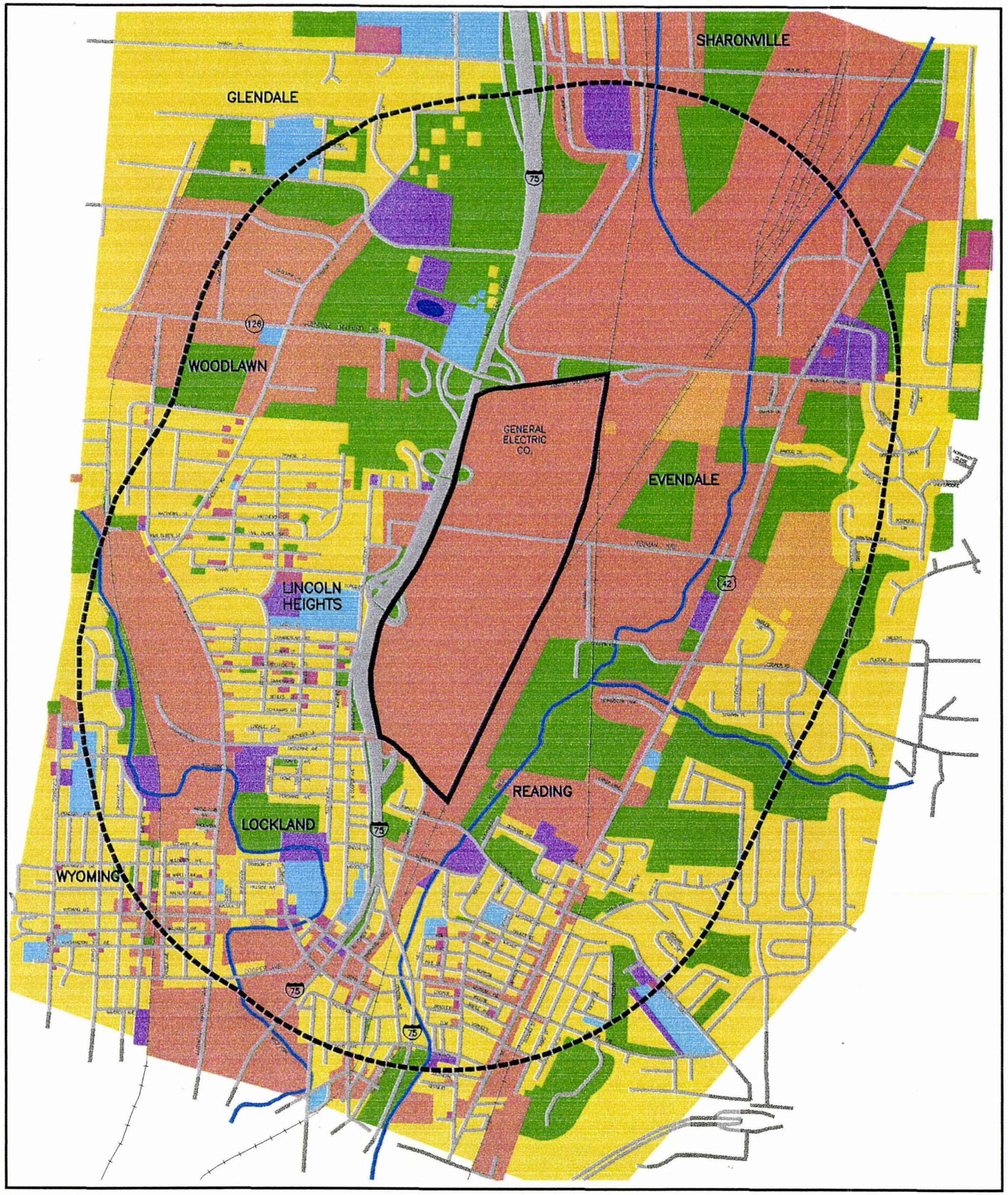
CHKD	DATE
APPD	DATE
SCALE	AS SHOWN

CENSUS TRACTS
WITHIN THE STUDY AREA

Filename: R:\3673\3673d005.dwg

DRAWING NUMBER
FIGURE 3-3



N

SCALE

0 1000' 2000' 3000'

LEGEND

Railroad
Study Area Boundary
GEAE Facility Boundary

LAND USE

Agricultural
Industrial / Commercial
Communal
Educational
Forest / Field / Wetland
Recreational
Residential
Surface Water

G.E. AIRCRAFT ENGINES FACILITY
EVENDALE, OHIO

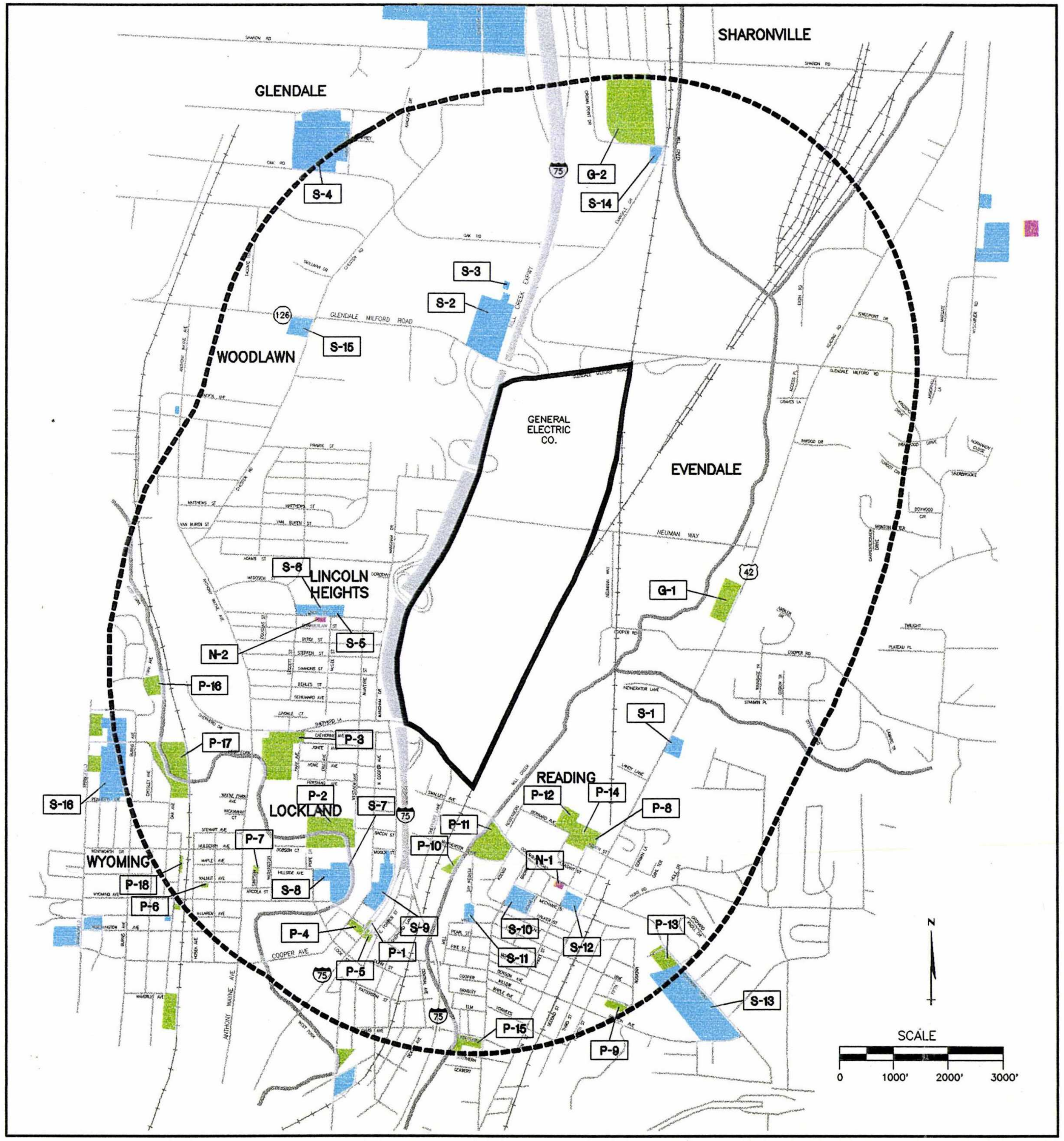
McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

DRWN: TML	DATE: 11-96
CHKD	DATE
APPD	DATE
SCALE	AS SHOWN

CURRENT LAND USE
WITHIN THE STUDY AREA

Filename: R:\3673\3673d006.dwg

DRAWING NUMBER
FIGURE 3-4



LEGEND

- Railroad
- Study Area Boundary
- GEAE Facility Boundary
- Surface Water

POTENTIALLY SENSITIVE SUBPOPULATIONS AND RECREATIONAL AREAS

SCHOOLS AND CHILD CARE FACILITIES

S	
S-1	Kids Are Fun
S-2	St. Rita School for the Deaf
S-3	Landmark Christian Schools, Landmark Kiddie Kollege
S-4	Bethany School
S-5	Smith-Flowers Head Start / Lincoln Heights Child Care (Head Start)
S-6	Lincoln Heights Elementary School
S-7	Lockland Elementary School
S-8	Lockland Middle School
S-9	Lockland High School
S-10	Central Elementary School
S-11	Sts. Peter & Paul
S-12	Reading Junior Senior High School
S-13	Mt Notre Dame Academy
S-14	Noah's Ark Christian Academy
S-15	Southern Ohio College
S-16	Wyoming High School

RECREATIONAL

P	
P-1	Freight Station Park
P-2	Gardner Park
P-3	Jonte Park
P-4	Richardson Park
P-5	Tangeman Park
P-6	Tot Lot
P-7	Wayne Park
P-8	Centennial Park
P-9	Flege Park
P-10	Haffey Fields
P-11	Koenig Park
P-12	Morton Fields
P-13	Observatory Park
P-14	Veteran's Memorial Stadium
P-15	Vorhees Park
P-16	North Park Field
P-17	Oak Park / Oak Playground
P-18	Van Roberts Playground

G	
G-1	Putt Putt Golf & Games
G-2	Golden Tee Putt Putt & Driving Range

NURSING HOMES

N	
N-1	Columbia Health Care Center
N-2	Lindy Manor Nursing Home

G.E. AIRCRAFT ENGINES FACILITY
EVENDALE, OHIO

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

DRWN: TML	DATE: 11-96
CHKD	DATE
APPD	DATE
SCALE	AS SHOWN

POTENTIALLY SENSITIVE SUBPOPULATIONS

Filename: R:\3673\3673d007.dwg

DRAWING NUMBER
FIGURE 3-5

4.0 DATA EVALUATION

The purpose of this section is to discuss the data which are available for the site (Section 4.1), (2) identify chemicals as preliminary chemicals of interest (PCOIs) from these data (Section 4.2), and (3) discuss how data for PCOIs will be evaluated in the quantitative risk assessment (Section 4.3).

4.1 Sources of Environmental Data

The following data sources were incorporated into the database used to identify PCOIs in Sections 4.2 and will be used to support the risk assessment for the facility.

- RCRA Facility Investigation (RFI) - Data for investigations conducted by O'Brien and Gere, and Rust Geotech, including:

    1. *Plant 36 Data* - Soil, groundwater, and sediment data collected between April 1990 and October 1992;

    2. *Phase I Data* - Soil, groundwater, and sediment data collected between April and November 1992; and

    3. *Phase II Data* - Soil, groundwater, and sediment data collected between June 1993 and June 1994.

- Plant 36 groundwater data collected by USGS (1994) in June 1994.

In addition, historical Plant 36 groundwater data collected in November 1987 and November 1988 by Geraghty and Miller (1987, 1988) may be used for fate and transport modeling to characterize constituent levels in groundwater.

Based on a graphical depiction of these data sets (Figures 4-1 through 4-85), potential data gaps/limitations were identified in soil (Aroclor-1254, Aroclor-1260, benzene, carbon disulfide, cis-1,2-dichloroethene, methylene chloride, tetrachloroethane, and vinyl chloride), sediment (benzene), and groundwater (benzene, bis(2-ethylhexyl)phthalate, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, cis-1,2-dichloroethene, methylene chloride, n-nitroso-diphenylamine, 1,1,2,2-tetrachloroethane, tetrachloroethene, and 1,1,2-trichloroethane) due to the presence of unusually high detection limits (*i.e.*, detection limits exceed the maximum detected concentration for at least one sample, possibly due to matrix effects or interference from other chemicals present at high concentrations).

4.2 Identification of PCOIs for Soil, Sediment, and Groundwater

4.2.1 PCOIs in Soil

4.2.1.1 Background Levels

Site-specific background data collected for soils were used to calculate upper background levels (UBLs), which were used to determine if the concentrations of inorganics in site soils have been impacted by site activities (*i.e.*, elevated above background). Upper background levels were calculated as described below.

The underlying distribution of concentration values was determined for each inorganic present in soil using the D'Agostino-Pearson K^2 test (D'Agostino *et al.*, 1990), which examines statistics for skewness and kurtosis. Data distributions were characterized as either "normal", "lognormal" or "undefined". Since this test requires a minimum of 8 samples, of which more than one half should consist of actual detected concentrations, any data set which does not meet these requirements was characterized as "not determined". Data distributions characterized as either "undefined" or "not determined" were assumed to be lognormal (USEPA, 1992c). Upper background levels were calculated for each inorganic based on the underlying distribution:

- *Normally Distributed Data* - The UBL was calculated as the arithmetic mean plus two standard deviations.

$$UBL = \bar{x} + 2 * SD$$

where:

$\bar{x}$	=	arithmetic mean; and
SD	=	standard deviation.

- *Lognormally Distributed Data* - The natural logarithm was calculated for each data point. The UBL was calculated as the inverse natural log of the arithmetic mean of the transformed data plus two standard deviations.

$$UBL = e^{(\bar{x}_t + 2 * SD_t)}$$

where:

$\bar{x}_t$	=	arithmetic mean of the natural log-transformed data; and
SD_t	=	standard deviation of transformed data.

The UBLs represent approximately the 95th percentile background concentration for each inorganic chemical. A list of site-specific UBLs for soil, along with a statistical summary of the data on which they are based, is provided in Table 4-1.

4.2.1.2 Risk-Based Concentration Criteria

Two types of risk-based concentration criteria were obtained from U.S.EPA sources for comparison to site soil data for purposes of identifying PCOIs:

- Preliminary Remediation Goals (PRGs) (PRG, 1996) - PRGs for occupational exposure were considered appropriate for this site. These values are considered protective for a 25-year exposure of 70 kg adult to soil (via ingestion, dermal contact, and inhalation of volatiles) assuming a target hazard index of 1 and a target cancer risk of 1×10^{-6}.

- Soil Screening Levels (SSLs) (USEPA, 1996a) - SSLs for migration to groundwater were considered appropriate for this site. These values are considered protective of a receptor (residential) located downgradient of the source. These values conservatively assume there is an infinite source, uniform distribution, no attenuation, instantaneous equilibrium, and no NAPLs present. A dilution attenuation factor of 20 was used in deriving these values.

The comparison of the maximum concentration for each detected chemical at the site to the PRG was used to identify PCOIs for direct contact by workers at the site. Similarly, chemicals with maximum detected concentrations at the site that exceeded the SSL were identified as PCOIs for groundwater evaluation. A list of risk-based concentrations (RBCs) used for chemicals detected at the site is provided in Table 4-2.

4.2.1.3 Preliminary Chemicals of Interests

Summary statistics (detection frequency, minimum detected concentration, and maximum detected concentration) were determined for each chemical detected in site soil. The maximum detected concentration for each chemical was compared to the appropriate criteria (UBL, PRG, SSL). This evaluation is provided in Table 4-3.

For direct contact with soil, 14 chemicals were identified as PCOIs that exceeded their respective risk-based PRG including 9 organic compounds and 5 inorganic compounds.

Organic	**Organic** - cont.	**Inorganic**
Aroclor-1248	Total Petroleum Hydrocarbons	Arsenic
Aroclor-1254	Vinyl Chloride	Beryllium
Aroclor-1260		Lead
Benzene		Manganese
Benzo(a)pyrene		Nickel
Benzo(b)fluoranthene		
Trichloroethene		

For the protection of groundwater, 23 chemicals were identified as PCOIs that exceeded their respective SSL including 13 organic compounds and 10 inorganic compounds.

Organic	**Inorganic**
Aroclor-1248	Antimony
Aroclor-1260	Arsenic
Benzene	Cadmium
Dichloroethene, 1,2-	Calcium
Dichloroethene, Cis-1,2-	Copper
Ethylbenzene	Cyanide
Methylene Chloride	Lead
Tetrachloroethene	Mercury
Toluene	Nickel
Total Petroleum Hydrocarbons	Zinc
Trichloroethane, 1,1,1-	
Trichloroethene	
Vinyl Chloride	

To facilitate an evaluation of the extent (both in magnitude and number of samples) to which site concentrations exceeded the criteria, the data distributions for all PCOIs were plotted and compared to the criteria in Figures 4-1 through 4-27. For most PCOIs, the criteria exceedances are limited to a small number of samples within a few SWMUs/AOCs (see Section 4.2.4).

Section 4.2.4).

4.2.2 PCOIs in Sediment

4.2.2.1 Background Levels

Site-specific background data were not collected for sediment. For this reason, the UBLs calculated for soil were used to evaluate site sediment data (see Table 4-1).

4.2.2.2 Risk-Based Concentrations

Risk-based concentrations used to evaluate site sediment data were limited to PRGs for industrial exposures (PRG, 1996) (see Table 4-2).

4.2.2.3 Preliminary Chemicals of Interests

Summary statistics (detection frequency, minimum detected concentration, and maximum detected concentration) were determined for each chemical detected in site sediment. The maximum detected concentration for each chemical was compared to the appropriate criteria (background, direct contact). This evaluation is provided in Table 4-4.

For direct contact with sediment, 6 chemicals were identified as PCOIs that exceeded their respective risk-based PRG including 3 organic compounds and 3 inorganic compounds.

Organic	**Inorganic**
Benzene	Arsenic
Toluene	Lead
Xylenes	Manganese

To facilitate an evaluation of the extent (both in magnitude and number of samples) to which site concentrations exceeded the criteria, the data distributions for all PCOIs were plotted and compared to the criteria in Figures 4-28 through 4-33. For most PCOIs, the criteria exceedances are limited to a small number of samples within a few SWMUs/AOCs (see Section 4.2.4).

4.2.3 PCOIs in Groundwater

4.2.3.1 Background Levels

Site-specific background data collected for groundwater from three aquifers (perched, upper sand & gravel, lower sand & gravel) were segregated by aquifer and used in the following manner to determine if the concentrations of inorganics in site groundwater have been impacted by site activities (*i.e.*, elevated above background). Upper background levels were calculated for inorganics detected in each aquifer using the same methodology described for soil. Site-specific UBLs, along with a statistical summary of the data on which they are based, are provided in Tables 4-5 through 4-7 for each aquifer.

4.2.3.2 Comparison to Benchmarks

Three types of groundwater benchmarks were obtained for comparison to site groundwater:

- Maximum Contaminant Levels/Maximum Contaminant Level Goals (MCLs/MCLGs) obtained from USEPA (1996b).

- Chronic/Lifetime Health Advisories (HAs) obtained from USEPA (1996b).

- Preliminary Remediation Goals (PRGs) for tap water ingestion (PRG, 1996).

The hierarchy for selecting a criterion was (1) MCL, (2) HA, and (3) PRG. Chemicals for which the maximum detected concentration at the site exceeded the groundwater benchmark were identified as PCOIs for groundwater. A list of benchmarks used for chemicals detected at the site is provided in Table 4-8.

4.2.3.3 Preliminary Chemicals of Interest

Summary statistics (detection frequency, minimum detected concentration, and maximum detected concentration) were determined for each chemical detected in site groundwater. The maximum detected concentration for each chemical was compared to the appropriate criteria (background, groundwater benchmark). This evaluation is provided separately for each aquifer in Tables 4-9 through 4-11.

For groundwater, 31 chemicals were identified as PCOIs that exceeded a groundwater benchmark including 27 organic compounds and 4 inorganic compounds:

Organic	**Organic** - cont.	**Inorganic**
Aroclor-1242	Methylene Chloride	Arsenic
Aroclor-1248	Methylnaphthalene, 2-	Cadmium
Benzene	N-Nitrosodiphenylamine	Chromium
Bis(2-ethylhexyl)phthalate	Naphthalene	Nickel
Carbon Disulfide	Phenanthrene	
Chloromethane	Tetrachloroethane, 1,1,2,2-	
Dibenzofuran	Tetrachloroethene	
Dichloroethane, 1,1-	Total Petroleum Hydrocarbons	
Dichloroethane, 1,2-	Trichloroethane, 1,1,1-	
Dichloroethene, 1,1-	Trichloroethane, 1,1,2-	
Dichloroethene, 1,2-	Trichloroethene	
Dichloroethene, Cis-1,2-	Vinyl Acetate	
Dichloroethene, Trans-1,2-	Vinyl Chloride	
Fluorene		

To facilitate an evaluation of the extent (both in magnitude and number of samples) to which site concentrations exceeded the criteria, the data distributions for all PCOIs were plotted and compared to the groundwater benchmarks in Figures 4-34 through 4-85. For most PCOIs, the criteria exceedances are limited to a small number of samples within a few SWMUs/AOCs (see Section 4.2.4).

4.2.4 Evaluation of SWMU/AOCs

Chemicals with maximum concentrations exceeding both the UBLs and RBCs/benchmarks were evaluated further using a graphical depiction of the site data (Figures 4-1 through 4-85). This graphical comparison facilitated the identification of SWMUs/AOCs in which site levels potentially pose a health risk (*i.e.*, above RBCs).

4.2.4.1 Soil

A summary of SWMUs/AOCs in which chemical exceedances to risk-based criteria were identified for direct contact with soil and for groundwater impacts is provided in Tables 4-12 and 4-13, respectively. The following SWMUs/AOCs were identified because chemical concentrations measured in soil were above direct contact screening criteria (PRGs) or background levels (UBLs).

120	19	31	87
124	20	36	93/94
16	21/22	77	LD
17	27/28	79	PST
18	29/30	8/12	

The following SWMUs/AOCs were identified because chemical concentrations measured in soil were above screening criteria (SSLs) for potential leaching to groundwater.

123	27/28	700	A
136	29/30	79	H
14	31	8/12	K
141	36	86	LD
142	42	93/94	PST
18	62	98/99	W
21/22			

4.2.4.2 Sediment

A summary of SWMUs/AOCs in which chemical exceedances to risk-based criteria were identified for direct contact with sediment is provided in Table 4-14.

The following SWMUs/AOCs were identified because chemical concentrations measured in soil were above direct contact screening criteria (PRGs) or background levels.

117	119
118	227

4.2.4.3 Groundwater

A summary of SWMUs/AOCs in which chemical exceedances to benchmarks were identified for groundwater is provided in Table 4-15. The following SWMUs/AOCs were identified because chemical concentrations measured in underlying groundwater were above screening criteria:

0	16	61/67	95
100	20	62/63	98/99
123	27/28	86	LD
124	36	93/94	PST

4.2.5 Summary of Data Evaluation

Based on the use of conservative screening criteria, PCOIs for soil, sediment, and groundwater and SWMUs/AOCs of interest were identified. For each media of interest, the maximum detected concentration for each chemical was compared to appropriate background and risk-based criteria/benchmarks.

A chemical was identified as a PCOI for a medium if the maximum detected concentration exceeded all criteria/benchmarks. A total of 27, 6, and 29 chemicals were identified as PCOIs in soil, sediment, and groundwater, respectively. Chemicals which did not exceed the criteria/benchmarks will not be evaluated in the quantitative risk assessment. A total of 33, 4, and 16 areas of the site were identified for further consideration in the quantitative risk assessment pertaining to soil, sediment, and groundwater, respectively.

Based on the conservative screening procedures employed, specific chemicals have been identified for the quantitative risk assessment that will be conducted for the GE Evendale site. The remainder of this Work Plan presents the methodology that will be used to calculate potential health risks for those chemicals identified as PCOIs.

4.3 Data Evaluation Methodology for the Quantitative Risk Assessment

The purpose of the Data Evaluation section will be to identify representative data sets that can be used to quantify exposure and potential health risks. This section will briefly discuss the data collection and evaluation procedures applicable to the area/medium under consideration. The components of data evaluation will include:

- identification of relevant data sets;
- identification of COIs; and
- calculation of summary statistics for COIs

These aspects of the data evaluation process are discussed in greater detail below.

4.3.1 Identification of Relevant Data Sets

The purpose of this section will be to identify appropriate risk assessment data sets from the available data for use in the quantitative risk assessment. Soil, sediment, and groundwater data will be evaluated to determine potential source areas, exposure point concentrations, and to identify chemicals of interest. Unlike the PCOI selection process in which the total data set was used, the data for these media may be segregated by geographical area (*i.e.*, north, south, east, west) or depth (*i.e.*, surface, subsurface) prior to the identification of COIs.

4.3.2 Identification of COIs

Chemicals of interest will be selected for each media from the list of PCOIs (see Section 4.2) based on a frequency of detection evaluation and a comparison to background levels, as summarized below.

- *Frequency of Detection Evaluation* - For risk assessment purposes, chemicals detected in media at a frequency of 5% or less will be eliminated from further consideration if: (1) they are not detected at high concentrations (*i.e.*, concentrations greater than USEPA MCLs or USEPA Region IX PRGs) and (2) there is no reason to believe the chemical may have originated at the facility (USEPA, 1989a). Chemicals detected in soil are not likely to be eliminated on the basis of detection frequency since chemicals in soil are likely to be potentially site-related. Residual compounds or artifacts may be excluded using detection frequency for common laboratory contaminants like phthalates, methylene chloride, carbon disulfide, and dioxane.

- *Comparison to Background Concentrations* - Local background data for soil and groundwater have been provided in the RFI report (OBG, 1995a). The medium-specific UBLs (see Section 4.2) calculated for inorganic constituents in soil, perched groundwater, upper sand and gravel groundwater, and lower sand and gravel groundwater will be used to compare site-related chemical concentrations (*i.e.*, 95% upper confidence levels (UCLs)) to naturally occurring background levels to eliminate chemicals from the quantitative assessment that are clearly associated with background. UBLs calculated for soil will be used to evaluate site sediment data since site-specific background data were not collected for this medium.

Evaluation of Total Petroleum Hydrocarbon

Total petroleum hydrocarbon (TPH) contamination at the site will be evaluated in the quantitative risk assessment in accordance with guidance from the Bureau of Underground Storage Tank Regulations (BUSTR, 1994). The uncharacterized TPH fraction will be treated as an additional noncarcinogen using the toxicity parameters listed below.

CHRONIC TOXICITY VALUES FOR TPH

TPH Source (Group)	RfDo mg/kg-day	RfC mg/cubic meter	TPH Modeling Compound
Group 1 Gasoline Light Distillate	average of TEX	average of TEX	N-Hexane
Group 2 Diesel/Kerosene Middle Distillate	(average of TEX x .28) + average of TEX	(average of TEX x .28) + average of TEX	Naphthalene
Group 3 Lubricating Oil Heavy Distillate	4	GROUP 2 RfC x 4	Heptadecane or Naphthalene

T = Toluene
E = Ethylbenzene
X = Xylene

Specific constituents of TPH (*i.e.*, BTEX, PAHs) will also be evaluated in the quantitative risk assessment when analytical results are available and this may result in an overestimation of potential health risks. For areas of the site in which BTEX and/or PAHs comprise a significant fraction of TPH, a discussion of the uncertainties with the TPH approach will be provided.

4.3.3 Calculation of Summary Statistics for COIs

Summary statistics (detection frequency, detected range, mean, standard deviation, and 95% upper confidence limit of the mean) will be generated for each chemical identified as a PCOI in each medium. Statistical summaries will be generated for each chemical in accordance with the following guidelines:

- *Treatment of Field Sample Duplicates* - Duplicate samples will be averaged. If a chemical is detected in only one of two duplicate samples, the detected concentration will be averaged with the nondetect using one-half the detection limit. The combined samples will be considered a single sample for detection frequency purposes.

- *Treatment of Nondetects* - Nondetected values will be included in the summary statistics by using one-half the detection limit (USEPA, 1989a).

- *Calculation of Detection Frequency* - The frequency of detection for a chemical will be calculated as the number of detects (including "J" qualified data) over the total number of samples evaluated. Duplicate samples will be averaged and treated as a single sample for the purposes of determining detection frequencies.

- *Calculation of Range Detected* - The detected range will be expressed as the minimum and maximum concentrations detected (including "J" qualified data).

- *Calculation of Mean, Standard Deviation (SD), and 95% Upper Confidence Level (UCL) Values* - Since the distribution of each chemical in each medium will not be determined for all chemicals (see below), the arithmetic mean, standard deviation, and two values for the 95% UCL of the mean (normal and lognormal distribution) will be determined for each chemical in each medium.

The mean will be calculated as shown below.

$$\bar{x} = \frac{1}{n} \sum x_i$$

where:

$\bar{x}$	=	arithmetic mean concentration; and
n	=	sample number.

The standard deviation will be calculated as shown below.

$$SD = [(\frac{1}{n-1}) * \Sigma (x_i - \bar{x})^2]^{1/2}$$

where:

SD	=	arithmetic standard deviation;
n	=	sample number; and
$\bar{x}$	=	arithmetic mean concentration.

The 95% UCL of the mean will be calculated assuming that the chemical concentrations are normally and lognormally distributed.

Assuming Normality

$$UCL = \bar{x} + t_{0.95} * \frac{SD}{\sqrt{n}}$$

where:

$\bar{x}$	=	the arithmetic mean concentration;
$t_{0.95}$	=	statistic for the student's t-distribution, value dependent on the probability (0.95) and degrees of freedom (n-1) specified;
SD	=	the arithmetic standard deviation; and
n	=	sample number.

Assuming Lognormality

$$UCL = e^{(\bar{x}_t + 0.5 * SD_t^2 + \frac{SD_t * H}{\sqrt{n-1}})}$$

where:

e	=	constant (base of the natural log, equal to 2.718);
$\bar{x}_t$	=	arithmetic mean of the natural log-transformed concentrations;
SD_t	=	standard deviation of the natural log-transformed concentrations;
H	=	H-statistic value dependent on the probability (0.95), degrees of freedom (n-1), and SD_t specified; and
n	=	sample number.

For chemicals identified as COIs, the summary statistics described above will be used to generate exposure point concentrations for use in the risk assessment according to the following approach:

- The arithmetic mean concentration or the maximum detected concentration (whichever is lower) will be used to evaluate the most likely exposure (MLE) scenarios (see Section 5.2 for a discussion).

- The underlying distribution of concentration values will be determined for each COI in each medium as being normal, lognormal, or undefined using the D'Agostino-Pearson K^2 test (D'Agostino et al., 1990), which examines statistics for skewness and kurtosis. This test requires a minimum of 8 samples (preferably >20) of which more than one half should be actual detected concentrations. If the D'Agostino-Pearson K^2 test cannot be used due to small sample size or a large number of nondetect values, the data distribution will be assumed to be lognormal.

- For COIs determined to be normally distributed, the 95% UCL (assuming normality) or the maximum detected concentration (whichever is lower) will be used to evaluate the reasonable maximum exposure (RME) scenarios (see Section 5.2 for a discussion).

- For COIs determined to be lognormally distributed or are undefined, the 95% UCL (assuming lognormality) or the maximum detected concentration (whichever is lower) will be used to evaluate the RME scenarios.

This approach ensures that the risk assessment is consistent with U.S. EPA guidance regarding the concentration term (USEPA, 1992c).

TABLE 4-1

DERIVATION OF UPPER BACKGROUND LEVELS (UBLs) FOR INORGANICS DETECTED IN SOIL

Chemical	Detection Frequency	Distribution[a]	Mean	SD	Tmean	Tsd	UBL
Aluminum	9/9	Normal	1.3E+04	7.1E+03	9.2E+00	8.6E-01	2.7E+04
Antimony	2/9	Not Determined	4.7E+00	2.2E+00	1.5E+00	3.9E-01	9.5E+00
Arsenic	9/9	Lognormal	5.6E+00	2.1E+00	1.7E+00	3.7E-01	1.1E+01
Barium	6/9	Lognormal	6.0E+01	5.0E+01	3.6E+00	1.2E+00	3.9E+02
Beryllium	4/9	Not Determined	6.3E-01	5.2E-01	-7.2E-01	7.3E-01	2.1E+00
Calcium	9/9	Normal	5.5E+04	4.2E+04	1.0E+01	1.5E+00	1.4E+05
Chromium	9/9	Normal	1.4E+01	8.7E+00	2.5E+00	7.3E-01	3.2E+01
Cobalt	6/9	Normal	7.6E+00	4.5E+00	1.8E+00	7.1E-01	1.7E+01
Copper	9/9	Lognormal	1.5E+01	6.5E+00	2.6E+00	4.4E-01	3.3E+01
Iron	9/9	Lognormal	2.1E+04	1.3E+04	9.8E+00	6.9E-01	7.0E+04
Lead	9/9	Lognormal	1.3E+01	7.8E+00	2.4E+00	6.3E-01	3.9E+01
Magnesium	9/9	Normal	1.8E+04	1.5E+04	9.3E+00	1.1E+00	4.8E+04
Manganese	9/9	Lognormal	5.4E+02	4.6E+02	6.0E+00	7.8E-01	2.0E+03
Nickel	9/9	Lognormal	1.6E+01	8.5E+00	2.7E+00	5.7E-01	4.4E+01
Potassium	6/9	Lognormal	1.2E+03	9.1E+02	6.7E+00	9.6E-01	5.6E+03
Sodium	4/9	Not Determined	3.1E+02	1.1E+02	5.7E+00	2.9E-01	5.4E+02
Vanadium	9/9	Lognormal	2.6E+01	1.2E+01	3.1E+00	4.9E-01	6.1E+01
Zinc	9/9	Lognormal	5.9E+01	4.3E+01	3.9E+00	6.6E-01	1.8E+02

a Distribution determined using test described by D'Agostino et al. (1990).

TABLE 4-2
RISK-BASED CONCENTRATIONS FOR SOIL
(Page 1 of 2)

Chemical	Direct Contact[a]	Protection of Groundwater[b]
Acenaphthene	1.1E+02	1.2E+03
Acetone	8.8E+03	2.8E+01
Aluminum	1.0E+05	2.1E+06
Anthracene	5.7E+00	2.5E+04
Antimony	6.8E+02	1.6E+01
Aroclor-1248	3.4E-01	6.2E+00
Aroclor-1254	3.4E-01	6.2E+00
Aroclor-1260	3.4E-01	6.2E+00
Arsenic	2.4E+00	2.9E+01
Barium	1.0E+05	1.7E+03
Benzene	1.4E+00	3.4E-02
Benzo(a)Anthracene	1.0E+02 c	6.2E+00
Benzo(a)Pyrene	2.6E-01	8.2E+00
Benzo(b)Fluoranthene	2.6E+00	1.9E+01
Benzo(ghi)Perylene	1.0E+02 c	4.4E+03 c
Benzo(k)Fluoranthene	2.6E+01	4.4E+03 c
Beryllium	1.1E+00	6.3E+01
Bis(2-Ethylhexyl)Phthalate	1.4E+02	1.2E+04
Cadmium	8.5E+02	1.1E+01
Calcium	NA	1.6E+05
Carbon Disulfide	2.4E+01	5.6E+01
Chlorobenzene	2.2E+02	1.3E+00
Chromium	1.6E+07 d	5.0E+06
Chrysene	7.2E+00	6.2E+02
Cobalt	9.7E+04	1.6E+05
Copper	6.3E+04	4.4E+03
Cyanide	1.4E+04	4.0E+01
Dibenz(a,h)Anthracene	1.0E+02 c	6.0E+00
Dibenzofuran	1.4E+02	7.1E+00
Dichlorobenzene, 1,4-	8.5E+00	2.2E+00
Dichloroethane, 1,1-	1.7E+03	4.0E+01
Dichloroethene, 1,1-	8.0E-02	5.8E-02
Dichloroethene, 1,2-	1.2E+02	4.0E-01
Dichloroethene, Cis-1,2-	1.0E+02	4.0E-01
Dichloroethene, Trans-1,2-	2.7E+02	6.8E-01
Ethylbenzene	2.3E+02	1.3E+01
Fluoranthene	2.7E+04	1.2E+04
Fluorene	9.0E+01	1.6E+03
Indeno(1,2,3-cd)Pyrene	2.6E+00	5.4E+01
Iron	NA	2.1E+06
Lead	1.0E+03	1.1E+03
Magnesium	NA	NA
Manganese	4.3E+04	3.3E+05
Mercury	5.1E+02	3.3E+00
Methyl Ethyl Ketone	2.7E+04	1.7E+02
Methylene Chloride	1.8E+01	2.3E-02
Methylnaphthalene, 2-	2.4E+02 e	9.6E+02
Naphthalene	2.4E+02	2.4E+02
Nickel	3.4E+04	1.8E+02

TABLE 4-2
RISK-BASED CONCENTRATIONS FOR SOIL
(Page 2 of 2)

Chemical	Direct Contact[a]	Protection of Groundwater[b]
Pentanone, 4-Methyl-2-	2.8E+03	NA
Phenanthrene	1.0E+02 c	1.2E+03
Potassium	NA	4.9E+05
Pyrene	1.0E+02	8.8E+03
Selenium	8.5E+03	4.6E+00
Silver	8.5E+03	9.3E+01
Sodium	NA	1.4E+06
Tetrachloroethene	1.7E+01	5.8E-02
Thallium	1.4E+02 f	8.3E+00
Toluene	8.8E+02	1.2E+01
Trichloroethane, 1,1,1-	3.0E+03	1.9E+00
Trichloroethene	7.0E+00	4.4E-02
Vanadium	1.2E+04	9.8E+03
Vinyl Chloride	3.5E-02	1.3E-02
Xylene, O-	3.2E+02	1.9E+02
Xylenes	3.2E+02	1.9E+02
Zinc	1.0E+05	7.5E+03

NA Not available
a Industrial Preliminary Remediation Goal (PRG) (PRG, 1996).
b Soil Screening Level (SSL) for protection of groundwater (USEPA, 1996a).
c Value for pyrene used as a surrogate
d Value for trivalent chromium
e Value for naphthalene used as a surrogate
f Value for thallium chloride used

TABLE 4-3
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR SOIL[a]
(Page 1 of 2)

Chemical	Detection Frequency	Concentration (mg/kg) Minimum	Maximum	Background (UBL)	PRG	SSL	PCOI Direct Contact	PCOI Groundwater Protection
				INORGANICS				
Aluminum	178/178	1.6E+03	7.7E+04	2.7E+04	1.0E+05	2.1E+06	No	No
Antimony	86/178	1.0E-01	**5.0E+01**	9.5E+00	6.8E+02	**1.6E+01**	No	**Yes**
Arsenic	176/178	8.5E-01	**2.3E+02**	1.1E+01	**2.4E+00**	**2.9E+01**	**Yes**	**Yes**
Barium	148/178	5.3E+00	6.3E+02	3.9E+02	1.0E+05	1.7E+03	No	No
Beryllium	124/178	1.4E-01	**3.0E+00**	2.1E+00	**1.1E+00**	6.3E+01	**Yes**	No
Cadmium	66/178	1.7E-01	**3.2E+02**	NA	**8.5E+02**	**1.1E+01**	**No**	**Yes**
Calcium	178/178	2.0E+03	4.0E+05	1.4E+05	NA	1.6E+05	No[b]	Yes
Chromium	178/178	3.0E+00	4.8E+03	3.2E+01	1.6E+07	5.0E+06	No	No
Cobalt	124/178	8.2E-01	1.3E+02	1.7E+01	9.7E+04	1.6E+05	No	No
Copper	152/178	1.2E+00	**5.1E+03**	3.3E+01	6.3E+04	**4.4E+03**	No	**Yes**
Cyanide	9/164	7.0E-01	**1.5E+03**	NA	1.4E+04	**4.0E+01**	No	**Yes**
Iron	178/178	5.2E+02	4.7E+04	7.0E+04	NA	2.1E+06	No	No
Lead	178/178	2.0E+00	**3.5E+03**	3.9E+01	**1.0E+03**	**1.1E+03**	**Yes**	**Yes**
Magnesium	177/178	1.3E+02	5.0E+04	4.8E+04	NA	NA	No[b]	No
Manganese	178/178	1.5E+01	**4.9E+04**	2.0E+03	**4.3E+04**	3.3E+05	**Yes**	No
Mercury	21/178	1.0E-01	**6.3E+00**	NA	5.1E+02	**3.3E+00**	No	**Yes**
Nickel	158/178	2.4E+00	**3.8E+04**	4.4E+01	**3.4E+04**	**1.8E+02**	**Yes**	**Yes**
Potassium	118/178	2.4E+02	4.2E+03	5.6E+03	NA	4.9E+05	No	No
Selenium	33/159	1.2E-01	4.0E+00	NA	8.5E+03	4.6E+00	No	No
Silver	15/178	1.4E-01	3.4E+01	NA	8.5E+03	9.3E+01	No	No
Sodium	108/178	1.6E+02	4.2E+03	5.4E+02	NA	1.4E+06	No[b]	No
Thallium	39/178	9.3E-02	3.4E-01	NA	1.4E+02	8.3E+00	No	No
Vanadium	177/178	4.0E+00	1.6E+03	6.1E+01	1.2E+04	9.8E+03	No	No
Zinc	178/178	7.5E+00	**1.1E+04**	1.8E+02	1.0E+05	**7.5E+03**	No	**Yes**
				ORGANICS				
Acenaphthene	2/49	4.0E-01	6.4E-01	NA	1.1E+02	1.2E+03	No	No
Acetone	99/368	6.0E-03	1.5E+01	NA	8.8E+03	2.8E+01	No	No
Anthracene	2/49	9.0E-01	2.5E+00	NA	5.7E+00	2.5E+04	No	No
Aroclor-1248	14/80	6.3E-01	**3.9E+02**	NA	**3.4E-01**	**6.2E+00**	**Yes**	**Yes**
Aroclor-1254	4/80	1.7E+00	**4.0E+00**	NA	**3.4E-01**	6.2E+00	**Yes**	No
Aroclor-1260	2/81	1.5E+00	**9.0E+00**	NA	**3.4E-01**	**6.2E+00**	**Yes**	**Yes**
Benzene	13/368	6.0E-03	**1.8E+00**	NA	**1.4E+00**	**3.4E-02**	**Yes**	**Yes**
Benzo(a)Anthracene	4/49	3.9E-01	2.9E+00	NA	1.0E+02	6.2E+00	No	No
Benzo(a)Pyrene	4/49	3.6E-01	**2.5E+00**	NA	**2.6E-01**	8.2E+00	**Yes**	No
Benzo(b)Fluoranthene	5/49	5.2E-01	**4.6E+00**	NA	**2.6E+00**	1.9E+01	**Yes**	No
Benzo(ghi)Perylene	4/49	2.3E-01	1.6E+00	NA	1.0E+02	4.4E+03	No	No
Benzo(k)Fluoranthene	4/49	2.1E-01	1.4E+00	NA	2.6E+01	4.4E+03	No	No
				ORGANICS (Cont.)				

TABLE 4-3

IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR SOIL[a]

(Page 2 of 2)

Chemical	Detection Frequency	Concentration (mg/kg) Minimum	Maximum	Background (UBL)	PRG	SSL	PCOI Direct Contact	PCOI Groundwater Protection
Bis(2-Ethylhexyl)Phthalate	10/49	4.4E-01	1.4E+01	NA	1.4E+02	1.2E+04	No	No
Carbon Disulfide	1/368	7.0E-03	7.0E-03	NA	2.4E+01	5.6E+01	No	No
Chlorobenzene	2/368	7.0E-03	9.0E-03	NA	2.2E+02	1.3E+00	No	No
Chrysene	4/49	4.1E-01	2.4E+00	NA	7.2E+00	6.2E+02	No	No
Dibenz(a,h)Anthracene	1/49	3.7E-01	3.7E-01	NA	1.0E+02	6.0E+00	No	No
Dibenzofuran	2/49	3.4E-01	2.2E+00	NA	1.4E+02	7.1E+00	No	No
Dichlorobenzene, 1,4-	1/49	9.8E-01	9.8E-01	NA	8.5E+00	2.2E+00	No	No
Dichloroethane, 1,1-	4/368	1.0E-02	1.5E+00	NA	1.7E+03	4.0E+01	No	No
Dichloroethene, 1,1-	2/368	5.0E-03	3.8E-02	NA	8.0E-02	5.8E-02	No	No
Dichloroethene, 1,2-	15/178	6.0E-03	**1.2E+01**	NA	1.2E+02	**4.0E-01**	No	**Yes**
Dichloroethene, Cis-1,2-	5/73	6.0E-03	**9.5E-01**	NA	1.0E+02	**4.0E-01**	No	**Yes**
Dichloroethene, Trans-1,2-	3/190	5.7E-02	3.1E-01	NA	2.7E+02	6.8E-01	No	No
Ethylbenzene	18/368	1.1E-02	**3.3E+01**	NA	2.3E+02	**1.3E+01**	No	**Yes**
Fluoranthene	7/49	4.1E-01	5.9E+00	NA	2.7E+04	1.2E+04	No	No
Fluorene	3/49	4.3E-01	3.5E+00	NA	9.0E+01	1.6E+03	No	No
Indeno(1,2,3-cd)Pyrene	4/49	2.7E-01	1.6E+00	NA	2.6E+00	5.4E+01	No	No
Methyl Ethyl Ketone	24/342	1.1E-02	2.0E+00	NA	2.7E+04	1.7E+02	No	No
Methylene Chloride	16/368	5.0E-03	**4.9E-01**	NA	1.8E+01	**2.3E-02**	No	**Yes**
Methylnaphthalene, 2-	5/49	4.0E-01	1.1E+01	NA	2.4E+02	9.6E+02	No	No
Naphthalene	4/49	1.5E+00	5.5E+00	NA	2.4E+02	2.4E+02	No	No
Pentanone, 4-Methyl-2-	2/368	6.5E-02	2.3E-01	NA	2.8E+03	NA	No	No
Phenanthrene	6/49	5.7E-01	8.9E+00	NA	1.0E+02	1.2E+03	No	No
Pyrene	7/49	3.6E-01	7.0E+00	NA	1.0E+02	8.8E+03	No	No
Tetrachloroethene	24/368	6.0E-03	**3.6E+00**	NA	1.7E+01	**5.8E-02**	No	**Yes**
Toluene	34/368	5.0E-03	**5.1E+01**	NA	8.8E+02	**1.2E+01**	No	**Yes**
Total Petroleum Hydrocarbons	139/282	1.1E+01	**4.6E+04**	NA	NA	NA	**Yes**	**Yes**
Trichloroethane, 1,1,1-	95/368	6.0E-03	**3.0E+02**	NA	3.0E+03	**1.9E+00**	No	**Yes**
Trichloroethene	82/368	6.0E-03	**2.5E+01**	NA	**7.0E+00**	**4.4E-02**	**Yes**	**Yes**
Vinyl Chloride	5/368	2.0E-02	**5.9E-01**	NA	**3.5E-02**	**1.3E-02**	**Yes**	**Yes**
Xylene, O-	3/73	1.3E-02	5.9E+01	NA	3.2E+02	1.9E+02	No	No
Xylenes	23/368	9.0E-03	1.4E+02	NA	3.2E+02	1.9E+02	No	No

a Bolded chemicals exceed criteria for direct contact or protection of groundwater.

b These chemicals were not considered a direct contact hazard since they are essential nutrients.

NA Not available

PRG - Preliminary Remediation Goal

SSL - Soil Screening Level

PCOI - Preliminary Chemicals of Interest

TABLE 4-4

IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST IN SEDIMENT[a]

Chemical	Detection Frequency	Concentration (mg/kg) Minimum	Maximum	UBL	PRG	PCOI
INORGANICS						
Aluminum	27/27	4.5E+02	1.5E+04	2.7E+04	1.0E+05	No
Antimony	2/27	8.0E+00	2.6E+01	9.5E+00	6.8E+02	No
Arsenic	23/27	3.8E+00	**2.7E+01**	**1.1E+01**	**2.4E+00**	**Yes**
Barium	17/27	3.5E+01	1.7E+03	3.9E+02	1.0E+05	No
Beryllium	5/27	9.0E-01	1.6E+00	2.1E+00	1.1E+00	No
Cadmium	26/27	1.6E+00	5.8E+02	NA	8.5E+02	No
Calcium[b]	27/27	1.4E+04	2.0E+05	1.4E+05	NA	No
Chromium	26/27	1.4E+01	7.8E+02	3.2E+01	1.6E+07	No
Cobalt	12/27	1.0E+01	1.4E+02	1.7E+01	9.7E+04	No
Copper	26/27	2.0E+01	1.6E+03	3.3E+01	6.3E+04	No
Cyanide	1/3	1.2E+00	1.2E+00	NA	1.4E+04	No
Iron[b]	27/27	1.7E+03	2.3E+05	7.0E+04	NA	No
Lead	27/27	1.5E+01	**1.8E+03**	**4.2E+01**	**1.0E+03**	**Yes**
Magnesium	24/27	5.4E+03	4.7E+04	4.8E+04	NA	No
Manganese	27/27	6.9E+01	**8.2E+04**	**2.0E+03**	**4.3E+04**	**Yes**
Mercury	20/27	6.0E-02	6.9E+00	NA	5.1E+02	No
Nickel	26/27	1.5E+01	1.3E+03	4.4E+01	3.4E+04	No
Potassium	1/27	1.3E+03	1.3E+03	5.6E+03	NA	No
Selenium	1/27	1.2E+01	1.2E+01	NA	8.5E+03	No
Silver	11/27	2.0E+00	7.0E+01	NA	8.5E+03	No
Sodium[b]	3/27	6.0E+02	3.7E+03	5.4E+02	NA	No
Vanadium	8/27	1.4E+01	9.7E+01	6.1E+01	1.2E+04	No
Zinc	27/27	9.0E+01	4.0E+03	1.8E+02	1.0E+05	No
ORGANICS						
Acetone	6/29	1.2E-02	3.4E+00	NA	8.8E+03	No
Benzene	2/29	1.3E+01	**1.0E+02**	NA	**1.4E+00**	**Yes**
Dichloroethane, 1,1-	2/29	1.1E-02	6.2E+01	NA	1.7E+03	No
Ethylbenzene	1/29	8.9E+01	8.9E+01	NA	2.3E+02	No
Methyl Ethyl Ketone	2/29	2.0E-02	1.1E+00	NA	2.7E+04	No
Methylene Chloride	1/29	1.6E+00	1.6E+00	NA	1.8E+01	No
Toluene	5/29	1.3E+00	**3.8E+03**	NA	**8.8E+02**	**Yes**
Trichloroethane, 1,1,1-	1/29	7.4E+02	7.4E+02	NA	3.0E+03	No
Trichloroethene	1/29	6.0E-03	6.0E-03	NA	7.0E+00	No
Xylene, O-	2/25	3.4E+01	1.9E+02	NA	3.2E+02	No
Xylenes	4/29	7.2E+01	**6.2E+03**	NA	**3.2E+02**	**Yes**

a Bolded chemicals exceed criteria for direct contact or protection of groundwater.
b These chemicals were not considered a direct contact hazard since they are essential nutrients.
NA Not available
UBL - Upper Background Level
PRG - Preliminary Remediation Goal
PCOI - Preliminary Chemicals of Interest

TABLE 4-5

DERIVATION OF UPPER BACKGROUND LEVELS FOR PERCHED GROUNDWATER

			Concentration (mg/kg)						
Chemical	Detection Frequency	Distribution	Minimum	Maximum	Mean	SD	Tmean	Tsd	Upper Background Level
Aluminum	8/8	Lognormal	0.63	65.8	1.2E+01	2.2E+01	1.5E+00	1.4E+00	7.2E+01
Arsenic	5/8	Normal	0.01	0.0454	1.7E-02	1.7E-02	-4.8E+00	1.6E+00	5.1E-02
Barium	7/8	Lognormal	0.0795	0.451	1.8E-01	1.3E-01	-1.9E+00	6.3E-01	5.3E-01
Beryllium	4/8	Lognormal	0.0007	0.0045	1.9E-03	1.4E-03	-6.5E+00	7.5E-01	6.8E-03
Cadmium	5/8	Lognormal	0.0011	0.0052	2.7E-03	1.3E-03	-6.0E+00	5.4E-01	6.9E-03
Calcium	8/8	Undefined	12	681	2.3E+02	2.0E+02	5.1E+00	1.1E+00	1.5E+03
Chromium	7/8	Lognormal	0.02	0.136	4.5E-02	3.9E-02	-3.4E+00	9.3E-01	2.1E-01
Cobalt	5/8	Lognormal	0.0198	0.0735	4.3E-02	2.3E-02	-3.3E+00	5.4E-01	1.1E-01
Copper	6/8	Normal	0.026	0.162	7.5E-02	6.5E-02	-3.2E+00	1.5E+00	2.1E-01
Iron	8/8	Lognormal	3.28	160	3.6E+01	5.1E+01	3.0E+00	1.2E+00	2.0E+02
Lead	6/8	Normal	0.012	0.0841	3.4E-02	3.2E-02	-4.1E+00	1.6E+00	9.7E-02
Magnesium	6/8	Lognormal	30	177	7.6E+01	5.9E+01	4.1E+00	6.8E-01	2.4E+02
Manganese	8/8	Lognormal	0.271	3.93	1.4E+00	1.2E+00	4.0E-02	8.2E-01	5.3E+00
Nickel	4/8	Normal	0.0677	0.158	5.7E-02	5.2E-02	-3.4E+00	1.3E+00	1.6E-01
Potassium	2/8	Not Determined	2.82	19.9	5.5E+00	6.0E+00	1.4E+00	7.2E-01	1.7E+01
Selenium	5/8	Undefined	0.0024	0.0354	7.4E-03	1.1E-02	-5.5E+00	9.3E-01	2.7E-02
Sodium	5/8	Lognormal	11	130	4.3E+01	4.0E+01	3.4E+00	9.0E-01	1.8E+02
Thallium	1/8	Not Determined	0.0015	0.0015	NA	NA	-6.6E+00	1.1E+00	1.3E-02
Vanadium	8/8	Lognormal	0.0011	0.5	9.8E-02	1.7E-01	-3.5E+00	1.8E+00	1.2E+00
Zinc	6/8	Lognormal	0.1	0.418	1.5E-01	1.2E-01	-2.2E+00	8.4E-01	6.1E-01

TABLE 4-6

DERIVATION OF UPPER BACKGROUND LEVELS FOR UPPER SAND AND GRAVEL GROUNDWATER

			Concentration (mg/kg)						
Chemical	**Detection Frequency**	**Distribution**	**Minimum**	**Maximum**	**Mean**	**SD**	**Tmean**	**Tsd**	**Upper Background Level**
Acetone	2/4	Not Determined	0.006	0.017	8.3E-03	5.9E-03	-4.9E+00	5.9E-01	2.3E-02
Aluminum	4/4	Not Determined	3.7	47	1.9E+01	1.9E+01	2.6E+00	1.1E+00	1.1E+02
Arsenic	3/4	Not Determined	0.008	0.035	1.3E-02	1.5E-02	-4.8E+00	1.1E+00	7.5E-02
Barium	3/4	Not Determined	0.3	0.7	4.0E-01	2.6E-01	-1.1E+00	8.5E-01	1.8E+00
Beryllium	1/4	Not Determined	0.006	0.006	3.4E-03	1.8E-03	-5.8E+00	4.4E-01	7.5E-03
Calcium	4/4	Not Determined	150	450	2.8E+02	1.5E+02	5.5E+00	5.4E-01	7.5E+02
Chromium	4/4	Not Determined	0.02	0.1	5.3E-02	3.9E-02	-3.2E+00	8.4E-01	2.2E-01
Copper	3/4	Not Determined	0.039	0.086	4.6E-02	3.0E-02	-3.3E+00	8.1E-01	1.9E-01
Iron	4/4	Not Determined	7.9	88	4.2E+01	3.3E+01	3.4E+00	1.0E+00	2.3E+02
Lead	4/4	Not Determined	0.01	0.072	3.2E-02	2.7E-02	-3.7E+00	8.1E-01	1.3E-01
Magnesium	4/4	Not Determined	29	95	6.2E+01	2.8E+01	4.0E+00	5.1E-01	1.6E+02
Manganese	4/4	Not Determined	0.72	2.8	1.7E+00	1.0E+00	3.6E-01	6.7E-01	5.5E+00
Nickel	3/4	Not Determined	0.04	0.08	4.8E-02	2.5E-02	-3.2E+00	5.8E-01	1.3E-01
Potassium	1/4	Not Determined	7	7	3.6E+00	2.3E+00	1.2E+00	5.1E-01	9.1E+00
Sodium	4/4	Not Determined	20	33	2.6E+01	5.3E+00	3.3E+00	2.0E-01	3.9E+01
Vanadium	4/4	Not Determined	0.05	0.13	7.0E-02	4.0E-02	-2.8E+00	4.8E-01	1.7E-01
Zinc	4/4	Not Determined	0.04	0.24	1.4E-01	8.2E-02	-2.2E+00	7.5E-01	5.1E-01

TABLE 4-7

DERIVATION OF UPPER BACKGROUND LEVELS FOR LOWER SAND AND GRAVEL GROUNDWATER

			Concentration (mg/kg)						
Chemical	Detection Frequency	Distribution	Minimum	Maximum	Mean	SD	Tmean	Tsd	Upper Background Level
Acetone	3/5	Not Determined	0.013	0.86	1.8E-01	3.8E-01	-3.8E+00	2.1E+00	1.6E+00
Aluminum	2/5	Not Determined	0.2	0.9	2.8E-01	3.5E-01	-1.7E+00	9.5E-01	1.2E+00
Arsenic	4/5	Not Determined	0.008	0.047	1.9E-02	1.8E-02	-4.4E+00	1.1E+00	1.2E-01
Barium	2/5	Not Determined	0.2	0.4	1.8E-01	1.3E-01	-1.9E+00	6.2E-01	5.2E-01
Calcium	5/5	Not Determined	38	120	8.6E+01	3.5E+01	4.4E+00	4.9E-01	2.1E+02
Chromium	2/5	Not Determined	0.02	0.04	1.5E-02	1.5E-02	-4.6E+00	9.8E-01	7.1E-02
Iron	5/5	Not Determined	1.1	7.2	3.5E+00	2.3E+00	1.1E+00	7.1E-01	1.2E+01
Magnesium	5/5	Not Determined	14	30	2.3E+01	6.3E+00	3.1E+00	3.0E-01	4.1E+01
Manganese	5/5	Not Determined	0.06	0.56	2.3E-01	2.0E-01	-1.8E+00	8.9E-01	1.0E+00
Potassium	1/5	Not Determined	13	13	4.6E+00	4.7E+00	1.2E+00	7.4E-01	1.5E+01
Sodium	5/5	Not Determined	18	53	3.2E+01	1.3E+01	3.4E+00	4.0E-01	6.6E+01
Vanadium	5/5	Not Determined	0.05	0.05	5.0E-02	6.6E-10	-3.0E+00	4.2E-08	5.0E-02
Zinc	4/5	Not Determined	0.03	0.06	3.4E-02	1.8E-02	-3.5E+00	6.6E-01	1.1E-01

TABLE 4-8
LIST OF GROUNDWATER BENCHMARKS

Chemical	Criteria (mg/L)	Source
Acenaphthene	3.7E-01	PRG
Acetone	6.1E-01	PRG
Aluminum	3.7E+01	PRG
Aroclor-1242	5.0E-04	MCL
Aroclor-1248	5.0E-04	MCL
Arsenic	5.0E-02	MCL
Barium	2.0E+00	MCL
Benzene	5.0E-03	MCL
Beryllium	4.0E-03	MCL
Bis(2-Ethylhexyl)Phthalate	4.8E-03	PRG
Bromophenyl Phenyl Ether, 4-	NA	MCL
Cadmium	5.0E-03	MCL
Calcium	NA	MCL
Carbon Disulfide	2.1E-02	PRG
Chlordane, alpha-	2.0E-03	MCL
Chloroethane	7.1E-01	PRG
Chloroform	1.0E-01	MCL
Chloromethane	3.0E-03	HA
Chromium	1.0E-01	MCL
Cobalt	2.2E+00	PRG
Copper	1.3E+00	MCL
DDT, 4,4'-	2.0E-04	PRG
Di-n-Butyl Phthalate	3.7E+00	PRG
Di-n-Octyl Phthalate	7.3E-01	PRG
Dibenzofuran	2.4E-02	PRG
Dibromochloromethane	1.0E-01	MCL
Dichloroethane, 1,1-	8.1E-01	PRG
Dichloroethane, 1,2-	5.0E-03	MCL
Dichloroethene, 1,1-	7.0E-03	MCL
Dichloroethene, 1,2-	7.0E-02	MCL
Dichloroethene, Cis-1,2-	7.0E-02	MCL
Dichloroethene, Trans-1,2-	1.0E-01	MCL
Dimethyl Phthalate	3.7E+02	PRG
Ethylbenzene	7.0E-01	MCL
Fluorene	2.4E-01	PRG
Heptachlor	4.0E-04	MCL
Hexanone, 2-	NA	MCL
Iron	NA	MCL
Lead	1.5E-02	MCL
Magnesium	NA	MCL
Manganese	1.7E+00	PRG
Mercury	2.0E-03	MCL
Methylene Chloride	5.0E-03	MCL
Methyl Ethyl Ketone	1.9E+00	PRG
Methylnaphthalene, 2-	2.4E-01	PRG
N-Nitrosodiphenylamine	1.4E-02	PRG
Naphthalene	2.0E-02	HA
Nickel	1.0E-01	MCL

TABLE 4-8
LIST OF GROUNDWATER BENCHMARKS
(Page 2 of 2)

Chemical	Criteria (mg/L)	Source
Pentanone, 4-Methyl-2-	1.6E-01	PRG
Phenanthrene	1.8E-01	PRG
Potassium	NA	MCL
Selenium	5.0E-02	MCL
Silver	1.0E-01	HA
Sodium	NA	MCL
Tetrachloroethane, 1,1,2,2-	5.5E-05	PRG
Tetrachloroethene	5.0E-03	MCL
Toluene	1.0E+00	MCL
Trichloroethane, 1,1,1-	2.0E-01	MCL
Trichloroethane, 1,1,2-	5.0E-03	MCL
Trichloroethene	5.0E-03	MCL
Vanadium	2.6E-01	PRG
Vinyl Acetate	4.1E-01	PRG
Vinyl Chloride	2.0E-03	MCL
Xylene, O-	1.0E+01	MCL
Xylenes	1.0E+01	MCL
Zinc	5.0E+00	MCL

MCL - Maximum Contaminant Level
PRG - Preliminary Remediation Goal
HA - Health Advisory

TABLE 4-9

IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR PERCHED GROUNDWATER

(Page 1 of 2)

Chemical	Detection Frequency	Concentration (mg/L) Minimum	Maximum	Upper Background Level	Risk-Based Criterion	PCOI
INORGANICS						
Aluminum	28/32	1.9E-03	3.4E+01	7.2E+01	3.7E+01	No
Arsenic	16/32	8.5E-04	**7.6E-02**	**5.1E-02**	**5.0E-02**	**Yes**
Barium	15/32	1.3E-04	1.0E+00	5.3E-01	2.0E+00	No
Cadmium	10/32	5.5E-04	**1.3E-02**	**6.9E-03**	**5.0E-03**	**Yes**
Calcium	31/32	1.4E-02	5.4E+02	1.5E+03	NA	No
Chromium	22/32	2.1E-05	**3.4E-01**	**2.1E-01**	**1.0E-01**	**Yes**
Cobalt	11/32	1.2E-03	8.3E-02	1.1E-01	2.2E+00	No
Copper	13/32	2.9E-02	1.8E-01	2.1E-01	1.3E+00	No
Iron	32/32	6.4E-03	1.2E+02	2.0E+02	NA	No
Lead	22/32	1.4E-05	4.8E-02	9.7E-02	1.5E-02	No
Magnesium	31/32	3.8E-02	1.5E+02	2.4E+02	NA	No
Manganese	32/32	1.0E-04	4.1E+00	5.3E+00	1.7E+00	No
Nickel	17/32	1.0E-02	**8.3E-01**	**1.6E-01**	**1.0E-01**	**Yes**
Potassium	14/32	2.4E-03	1.7E+01	1.7E+01	NA	No
Selenium	11/32	1.9E-03	2.0E-02	2.7E-02	5.0E-02	No
Sodium	30/32	2.7E-02	1.9E+02	1.8E+02	NA	No[a]
Vanadium	13/32	2.4E-03	1.0E-01	1.2E+00	2.6E-01	No
Zinc	14/32	2.9E-05	3.6E-01	6.1E-01	5.0E+00	No
ORGANICS						
Acenaphthene	1/24	2.6E-01	2.6E-01	NA	3.7E-01	No
Acetone	9/59	3.7E-03	2.4E-02	NA	6.1E-01	No
Aroclor-1242	1/21	7.2E-04	**7.2E-04**	NA	**5.0E-04**	**Yes**
Aroclor-1248	2/21	2.0E-04	**2.6E-02**	NA	**5.0E-04**	**Yes**
Benzene	4/60	6.5E-03	**2.0E-01**	NA	**5.0E-03**	**Yes**
Bis(2-Ethylhexyl)Phthalate	7/24	1.0E-03	**5.3E-01**	NA	**4.8E-03**	**Yes**
Chloroethane	1/57	8.4E-02	8.4E-02	NA	7.1E-01	No
Chloroform	1/60	1.1E-03	1.1E-03	NA	1.0E-01	No
Di-n-Butyl Phthalate	1/24	1.0E-03	1.0E-03	NA	3.7E+00	No
Dibenzofuran	1/24	3.0E-01	**3.0E-01**	NA	**2.4E-02**	**Yes**
Dichloroethane, 1,1-	21/61	4.0E-03	2.7E-01	NA	8.1E-01	No
Dichloroethane, 1,2-	6/60	2.5E-03	**1.2E-02**	NA	**5.0E-03**	**Yes**
Dichloroethene, 1,1-	13/61	4.0E-03	**1.5E-01**	NA	**7.0E-03**	**Yes**
Dichloroethene, 1,2-	9/27	4.3E-03	**1.1E-01**	NA	**7.0E-02**	**Yes**

TABLE 4-9
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR PERCHED GROUNDWATER
(Page 2 of 2)

Chemical	Detection Frequency	Concentration (mg/L)				PCOI
		Minimum	Maximum	Upper Background Level	Risk-Based Criterion	
ORGANICS (Cont.)						
Dichloroethene, Cis-1,2-	11/22	1.2E-02	**2.4E-01**	NA	**7.0E-02**	Yes
Dichloroethene, Trans-1,2-	10/33	1.2E-03	7.0E-03	NA	1.0E-01	No
Ethylbenzene	2/60	5.3E-03	8.0E-03	NA	7.0E-01	No
Fluorene	1/24	5.5E-01	**5.5E-01**	NA	**2.4E-01**	Yes
Hexanone, 2-	2/59	1.5E-02	1.8E-02	NA	NA	No
Methylene Chloride	6/61	1.4E-03	**2.7E-02**	NA	**5.0E-03**	Yes
Methylnaphthalene, 2-	4/24	5.0E-03	**1.1E+01**	NA	**2.4E-01**	Yes
N-Nitrosodiphenylamine	2/24	6.0E-03	**1.6E-02**	NA	**1.4E-02**	Yes
Naphthalene	2/24	1.1E-02	**3.0E+00**	NA	**2.0E-02**	Yes
Phenanthrene	1/24	1.3E+00	**1.3E+00**	NA	**1.8E-01**	Yes
Tetrachloroethene	7/60	2.0E-03	**5.2E-02**	NA	**5.0E-03**	Yes
Total Petroleum Hydrocarbons	13/32	1.1E+00	**1.7E+05**	NA	**NA**	Yes
Trichloroethane, 1,1,1-	25/61	6.0E-03	**1.1E+01**	NA	**2.0E-01**	Yes
Trichloroethane, 1,1,2-	2/60	6.0E-03	**1.1E-02**	NA	**5.0E-03**	Yes
Trichloroethene	29/61	5.0E-03	**3.6E+00**	NA	**5.0E-03**	Yes
Vinyl Acetate	3/57	1.3E-02	**2.5E+00**	NA	**4.1E-01**	Yes
Vinyl Chloride	4/59	5.0E-03	**3.3E-02**	NA	**2.0E-03**	Yes
Xylene, O-	1/21	1.4E+00	1.4E+00	NA	1.0E+01	No
Xylenes	4/55	1.2E-02	3.2E+00	NA	1.0E+01	No

a These chemicals were not considered a direct contact hazard since they are essential nutrients.

TABLE 4-10
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR UPPER SAND AND GRAVEL GROUNDWATER
(Page 1 of 2)

Chemical	Detection Frequency	Concentration (mg/L) Minimum	Maximum	Upper Background Level	Risk-Based Criterion	PCOI
INORGANICS						
Aluminum	24/37	5.0E-03	1.1E+00	1.1E+02	3.7E+01	No
Arsenic	15/37	1.0E-05	1.9E-02	7.5E-02	5.0E-02	No
Barium	24/37	1.2E-04	6.2E-01	1.8E+00	2.0E+00	No
Beryllium	3/37	5.0E-06	1.0E-05	7.5E-03	4.0E-03	No
Cadmium	7/37	2.0E-06	1.2E-05	NA	5.0E-03	No
Calcium	37/37	1.4E-01	1.5E+02	7.5E+02	NA	No
Chromium	20/37	2.3E-05	2.0E-02	2.2E-01	1.0E-01	No
Cobalt	8/37	6.0E-05	2.0E-04	NA	2.2E+00	No
Copper	18/37	3.0E-05	7.9E-04	1.9E-01	1.3E+00	No
Iron	35/37	2.4E-02	1.2E+01	2.3E+02	NA	No
Lead	23/37	3.0E-05	8.4E-03	1.3E-01	1.5E-02	No
Magnesium	37/37	3.6E-02	5.3E+01	1.6E+02	NA	No
Manganese	37/37	5.8E-04	1.9E+00	5.5E+00	1.7E+00	No
Mercury	2/37	2.0E-07	3.0E-07	NA	2.0E-03	No
Nickel	**17/37**	**4.0E-05**	**3.9E-01**	**1.3E-01**	**1.0E-01**	**Yes**
Potassium	19/37	3.4E-03	5.9E+00	9.1E+00	NA	No
Selenium	2/37	7.0E-06	1.4E-05	NA	5.0E-02	No
Silver	1/37	9.6E-04	9.6E-04	NA	1.0E-01	No
Sodium	37/37	3.3E-02	8.5E+01	3.9E+01	NA	No
Vanadium	15/37	5.0E-05	5.0E-02	1.7E-01	2.6E-01	No
Zinc	24/37	3.7E-05	3.9E-02	5.1E-01	5.0E+00	No
ORGANICS						
Acetone	7/42	1.0E-03	1.2E-01	NA	6.1E-01	No
Benzene	2/45	1.8E-03	**1.2E-02**	NA	**5.0E-03**	**Yes**
Bis(2-Ethylhexyl)Phthalate	7/18	2.0E-03	**1.2E-02**	NA	**4.8E-03**	**Yes**
Carbon Disulfide	1/45	2.2E-02	**2.2E-02**	NA	**2.1E-02**	**Yes**
Chloroethane	7/42	1.5E-02	3.2E-01	NA	7.1E-01	No
Chloromethane	1/40	2.0E-04	2.0E-04	NA	3.0E-03	No
Dichloroethane, 1,1-	38/45	3.8E-03	**6.2E+00**	NA	**8.1E-01**	**Yes**
Dichloroethane, 1,2-	5/45	1.1E-03	**1.0E-02**	NA	**5.0E-03**	**Yes**
Dichloroethene, 1,1-	24/45	2.3E-03	**1.0E-01**	NA	**7.0E-03**	**Yes**
Dichloroethene, 1,2-	13/18	2.0E-03	**1.7E-01**	NA	**7.0E-02**	**Yes**

TABLE 4-10
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR UPPER SAND AND GRAVEL GROUNDWATER
(Page 2 of 2)

Chemical	Detection Frequency	Concentration (mg/L)				PCOI
		Minimum	Maximum	Upper Background Level	Risk-Based Criterion	
			ORGANICS (Cont.)			
Dichloroethene, Cis-1,2-	19/22	4.0E-02	**7.5E-01**	NA	**7.0E-02**	Yes
Dichloroethene, Trans-1,2-	20/27	1.6E-03	**7.2E-01**	NA	**1.0E-01**	Yes
Dimethyl Phthalate	1/18	2.0E-03	2.0E-03	NA	3.7E+02	No
Fluorene	1/18	3.0E-03	3.0E-03	NA	2.4E-01	No
Hexanone, 2-	2/42	3.3E-03	3.5E-03	NA	NA	No
Methyl Ethyl Ketone	4/40	1.6E-02	3.9E-02	NA	1.9E+00	No
Methylene Chloride	7/45	1.2E-03	**2.5E-02**	NA	**5.0E-03**	Yes
N-Nitrosodiphenylamine	7/18	2.0E-03	**1.5E-02**	NA	**1.4E-02**	Yes
Pentanone, 4-Methyl-2-	1/40	2.7E-03	2.7E-03	NA	1.6E-01	No
Phenanthrene	1/18	2.0E-03	2.0E-03	NA	1.8E-01	No
Tetrachloroethene	2/45	4.3E-03	**9.0E-03**	NA	**5.0E-03**	Yes
Toluene	1/45	1.0E-02	1.0E-02	NA	1.0E+00	No
Trichloroethane, 1,1,1-	9/45	2.2E-02	**4.3E-01**	NA	**2.0E-01**	Yes
Trichloroethene	16/45	1.0E-03	**1.7E+00**	NA	**5.0E-03**	Yes
Vinyl Chloride	10/43	4.0E-03	**1.1E-01**	NA	**2.0E-03**	Yes

a These chemicals were not considered a direct contact hazard since they are essential nutrients.

TABLE 4-11
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR LOWER SAND AND GRAVEL GROUNDWATER
(Page 1 of 2)

Chemical	Detection Frequency	Concentration (mg/L) Minimum	Maximum	Upper Background Level	Risk-Based Level	PCOI
INORGANICS						
Aluminum	13/26	9.1E-04	8.0E-01	1.2E+00	3.7E+01	No
Arsenic	9/26	2.6E-05	4.1E-02	1.2E-01	5.0E-02	No
Barium	19/26	1.7E-04	7.3E-01	5.2E-01	2.0E+00	No
Cadmium	1/26	3.0E-06	3.0E-06	NA	5.0E-03	No
Calcium	26/26	1.2E-01	2.3E+02	2.1E+02	NA	No[a]
Chromium	14/26	1.3E-05	**2.8E-01**	**7.1E-02**	**1.0E-01**	**Yes**
Copper	6/26	3.5E-05	1.6E-02	NA	1.3E+00	No
Iron	26/26	2.1E-03	1.5E+01	1.2E+01	NA	No[a]
Lead	17/26	5.6E-06	6.3E-03	NA	1.5E-02	No
Magnesium	26/26	3.1E-02	4.1E+01	4.1E+01	NA	No
Manganese	26/26	5.9E-04	1.6E+00	1.0E+00	1.7E+00	No
Nickel	7/26	5.0E-05	**2.1E-01**	NA	**1.0E-01**	**Yes**
Potassium	9/26	1.2E-03	5.6E-03	1.5E+01	NA	No
Selenium	1/26	5.2E-06	5.2E-06	NA	5.0E-02	No
Sodium	26/26	3.1E-02	6.2E+01	6.6E+01	NA	No
Vanadium	4/26	5.0E-02	5.0E-02	5.0E-02	2.6E-01	No
Zinc	18/26	3.6E-05	7.6E-02	1.1E-01	5.0E+00	No
ORGANICS						
Acetone	5/34	3.7E-03	3.2E-01	NA	6.1E-01	No
Benzene	7/35	3.3E-03	**1.8E-01**	NA	**5.0E-03**	**Yes**
Bis(2-Ethylhexyl)Phthalate	8/14	2.0E-03	**6.6E-02**	NA	**4.8E-03**	**Yes**
Bromophenyl Phenyl Ether, 4-	1/14	3.0E-03	3.0E-03	NA	NA	Yes
Chlordane, Alpha-	1/20	2.0E-04	2.0E-04	NA	2.0E-03	No
Chloroethane	2/32	2.0E-03	1.1E-02	NA	7.1E-01	No
Chloromethane	1/32	4.1E-02	**4.1E-02**	NA	**3.0E-03**	**Yes**
DDT, 4,4'-	1/20	1.3E-04	1.3E-04	NA	2.0E-04	No
Di-n-Butyl Phthalate	9/14	1.0E-03	1.2E-01	NA	3.7E+00	No
Di-n-Octyl Phthalate	1/14	1.0E-02	1.0E-02	NA	7.3E-01	No
Dibromochloromethane	1/35	4.0E-03	4.0E-03	NA	1.0E-01	No
Dichloroethane, 1,1-	9/35	1.5E-03	1.5E-01	NA	8.1E-01	No
Dichloroethene, 1,1-	3/35	8.2E-03	**2.3E-02**	NA	**7.0E-03**	**Yes**
Dichloroethene, 1,2-	1/11	1.3E-02	1.3E-02	NA	7.0E-02	No

TABLE 4-11
IDENTIFICATION OF PRELIMINARY CHEMICALS OF INTEREST FOR LOWER SAND AND GRAVEL GROUNDWATER

Chemical	Detection Frequency	Concentration (mg/L) Minimum	Maximum	Upper Background Level	Risk-Based Level	PCOI
ORGANICS (Cont.)						
Dichloroethene, Cis-1,2-	8/18	1.4E-03	**2.4E-01**	NA	**7.0E-02**	**Yes**
Dichloroethene, Trans-1,2-	6/24	1.4E-03	4.2E-02	NA	1.0E-01	No
Dimethyl Phthalate	1/14	4.0E-03	4.0E-03	NA	3.7E+02	No
Ethylbenzene	1/35	2.6E-02	2.6E-02	NA	7.0E-01	No
Heptachlor	1/20	7.6E-05	7.6E-05	NA	4.0E-04	No
Methylene Chloride	6/35	1.6E-03	2.6E-03	NA	5.0E-03	No
N-Nitrosodiphenylamine	1/14	3.0E-03	3.0E-03	NA	1.4E-02	No
Tetrachloroethane, 1,1,2,2-	1/36	7.0E-03	**7.0E-03**	NA	**5.5E-05**	**Yes**
Toluene	3/36	1.8E-03	9.0E-03	NA	1.0E+00	No
Total Petroleum Hydrocarbons	1/8	8.0E+00	**8.0E+00**	NA	NA	**Yes**
Trichloroethane, 1,1,1-	1/36	1.8E-03	1.8E-03	NA	2.0E-01	No
Trichloroethene	7/36	1.4E-03	**3.0E-02**	NA	**5.0E-03**	**Yes**
Vinyl Chloride	6/34	2.0E-03	**7.0E-03**	NA	**2.0E-03**	**Yes**
Xylenes	1/28	3.6E-02	3.6E-02	NA	1.0E+01	No

a These chemicals were not considered a direct contact hazard since they are essential nutrients.

TA 4-12

SUMMARY OF PCOIs PER SWMU/AOC FOR DIRECT CONTACT WITH SOIL[a]

SWMU/AOC	*Aroclor-1248*	*Aroclor-1254*	*Aroclor-1260*	*Benzene*	*Benzo(a)Pyrene*	*Benzo(b)fluoranthene*	*Trichloroethene*	*Vinyl Chloride*	*Arsenic*	*Beryllium*	*Lead*	*Manganese*	*Nickel*	*Total*
8/12	14	2			1	1	2	1	3	2				26
21/22		2	1		1	1	2	1		2			1	11
PST							6							6
18									3	3				6
19									2	4				6
29/30									3	1	1			5
27/28									2	2				4
17									2	2				4
20					2	1								3
LD							2							2
79									1			1		2
36				1										1
93/94										1				1
31										1				1
120									1					1
124									1					1
16									1					1
77										1				1
87			1											1
Total	14	4	2	1	4	3	12	2	19	19	1	1	1	83

a Values in table represent the number of soil samples which exceed criteria; TPH is also a PCOI that will be evaluated in the quantitative assessment.

TABLE 4-13

SUMMARY OF PCOIs PER SWMU/AOC FOR PROTECTION OF GROUNDWATERa

SWMU/AOC	Aroclor-1248	Aroclor-1260	Benzene	Dichloroethene, 1,2-	Dichloroethene, Cis-1,2-	Ethylbenzene	Methylene Chloride	Tetrachloroethene	Toluene	Trichloroethane, 1,1,1-	Trichloroethene	Vinyl Chloride	Antimony	Arsenic	Cadmium	Calcium	Copper	Cyanide	Lead	Mercury	Nickel	Zinc	Total
8/12	7		5	5				2		9	3	4				4							39
PST										15	18												33
21/22		1									3	1	2		3	3	1	2			3		19
LD							1			4	13												18
29/30													1	1	1	5			1		1	1	11
36			1		1	1		2	1		2												8
14															1	3		1			2		7
79															3						3		6
W										2	3												5
700								2			2												4
93/94			2																				2
136											2												2
141											2												2
142								2															2
86											2												2
98/99											2												2
18																				1			1
27/28											1												1
31																1							1
123											1												1
42											1												1
62											1												1
A											1												1
H											1												1
K			1																				1
Total	7	1	9	5	1	1	1	8	1	30	58	5	3	1	8	16	1	3	1	1	9	1	171

a Values in table represent the number of soil samples which exceed criteria; TPH is also a PCOI that will be evaluated in the quantitative assessment.

TABLE 4-14

SUMMARY OF PCOIs IN SEDIMENT FOR SWMUs/AOCs[a]

SWMU/AOC	Arsenic	Benzene	Lead	Manganese	Toluene	Xylenes	Total
117		2		1		1	4
118	1		1				2
119	5		2				7
227					1	1	2
Total	6	2	3	1	1	2	15

a Values represent the number of samples exceeding criteria.

TABLE 4-15

SUMMARY OF PCOIs PER SWMU/AOC FOR GROUNDWATER[a]

SWMU/ AOC	Aquifer	Aroclor-1242	Aroclor-1248	Arsenic	Benzene	Bis(2-ethylhexyl)phthalate	Cadmium	Carbon Disulfide	Chloromethane	Chromium	Dibenzofuran	Dichloroethane, 1,1-	Dichloroethane, 1,2-	Dichloroethene, 1,1-	Dichloroethene, 1,2-	Dichloroethene, cis-1,2-	Dichloroethene, trans-1,2-	Fluorene	Methylene Chloride	Methylnaphthalene, 2-	N-Nitrosodiphenylamine	Naphthalene	Nickel	Phenanthrene	Tetrachloroethane, 1,1,2,2-	Tetrachloroethene	Trichloroethane, 1,1,1-	Trichloroethane, 1,1,2-	Trichloroethene	Vinyl Acetate	Vinyl Chloride	Grand Total
0	1-Perched																												1			1
	2-Upper				1			1				1					2						1									6
	3-Lower									1																						1
16	1-Perched					1							1																1			3
20	1-Perched					1																										1
27/28	3-Lower				2																											2
36	1-Perched				2	2	1			1	1		2	6		3		1	2	1	1	1	3	1		1	6	1	12		4	52
	2-Upper					2						2	3	18	6	14			2		1					1	6		13		10	78
	3-Lower				3	5			1	1				3		2							1		1				5		5	27
61/67	1-Perched				2																											2
62/63	1-Perched																												3			3
86	1-Perched													1	1												1		1			4
	2-Upper																										1					1
93/94	1-Perched	1																														1
95	1-Perched		1																										1			2
98/99	1-Perched																												1			1
100	1-Perched																													1		1
123	1-Perched																												1			1
124	1-Perched			1																									1			2
LD	1-Perched												1	1													3	1	3			9
	2-Upper																										3					3
PST	1-Perched																									2	1		3			6
	2-Upper																										1					1
Total		1	1	1	10	11	1	1	1	3	1	3	7	29	7	19	2	1	4	1	2	1	5	1	1	4	22	2	46	1	19	208

a TPH is also a PCOI that will be evaluated in the quantitative assessment.

Figure 4-1
Comparison of Antimony Soil Data to RBC Criteria

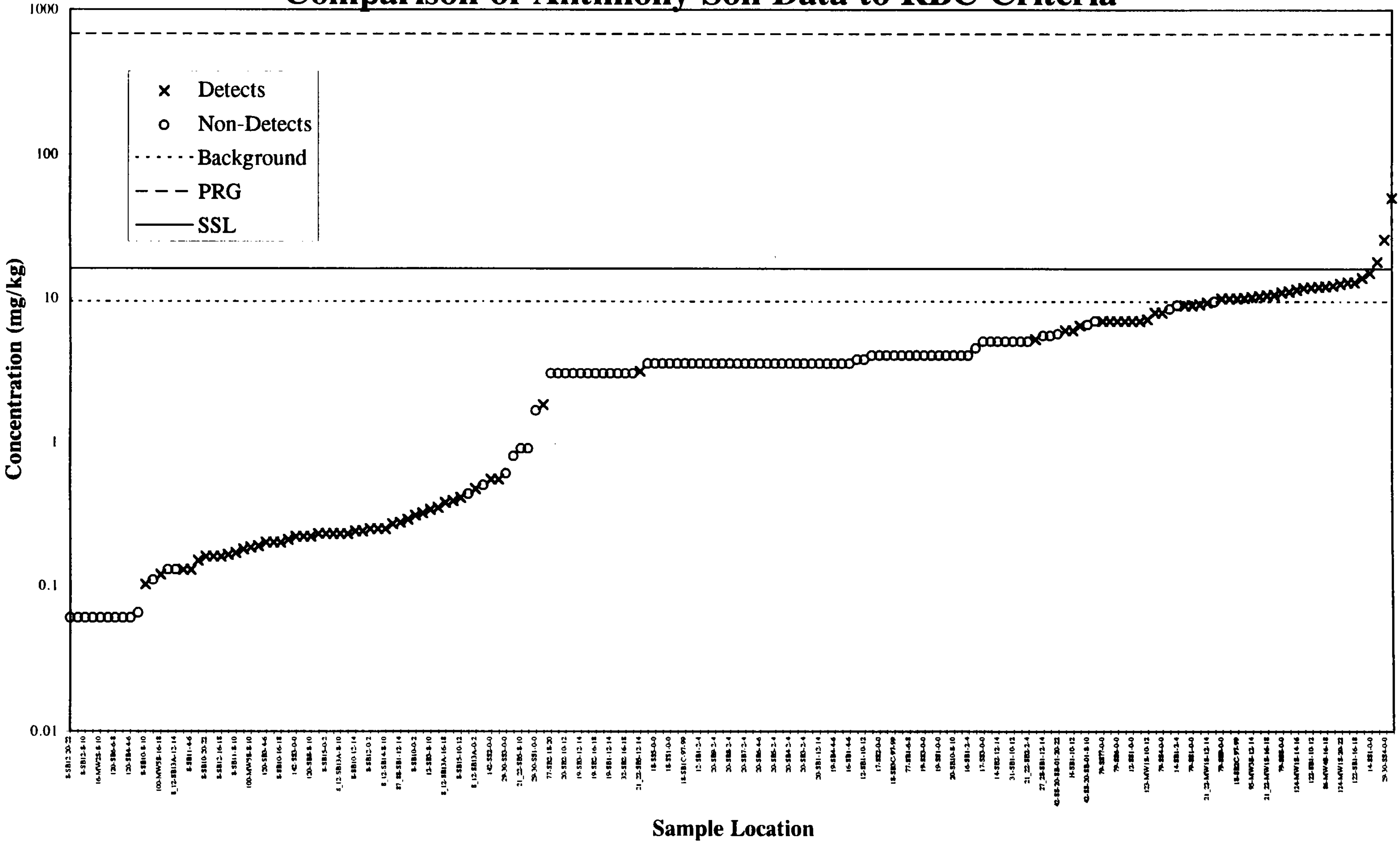


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Figure 4-2
Comparison of Aroclor-1248 Soil Data to RBC Criteria

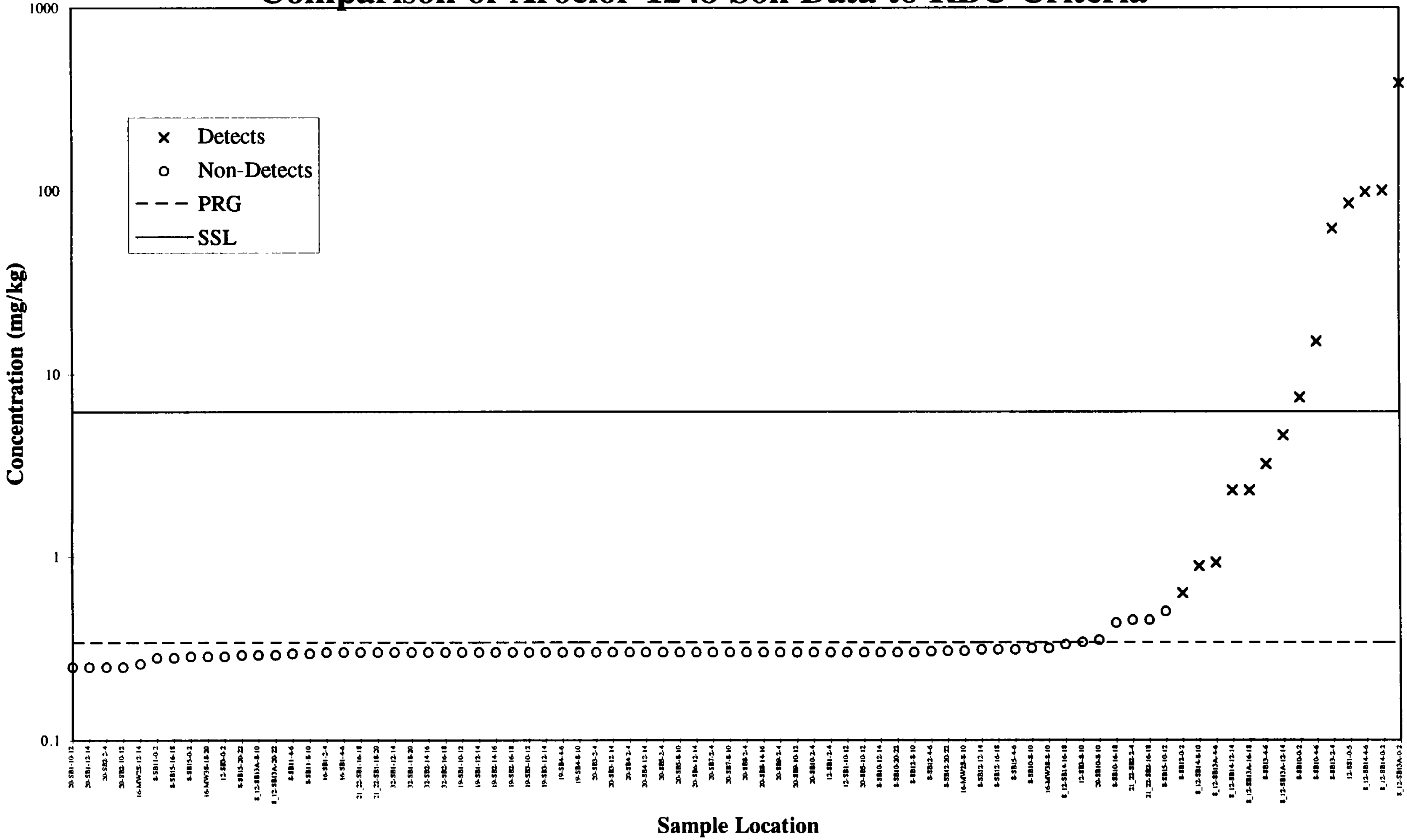

Figure 4-3
Comparison of Aroclor-1254 Soil Data to RBC Criteria

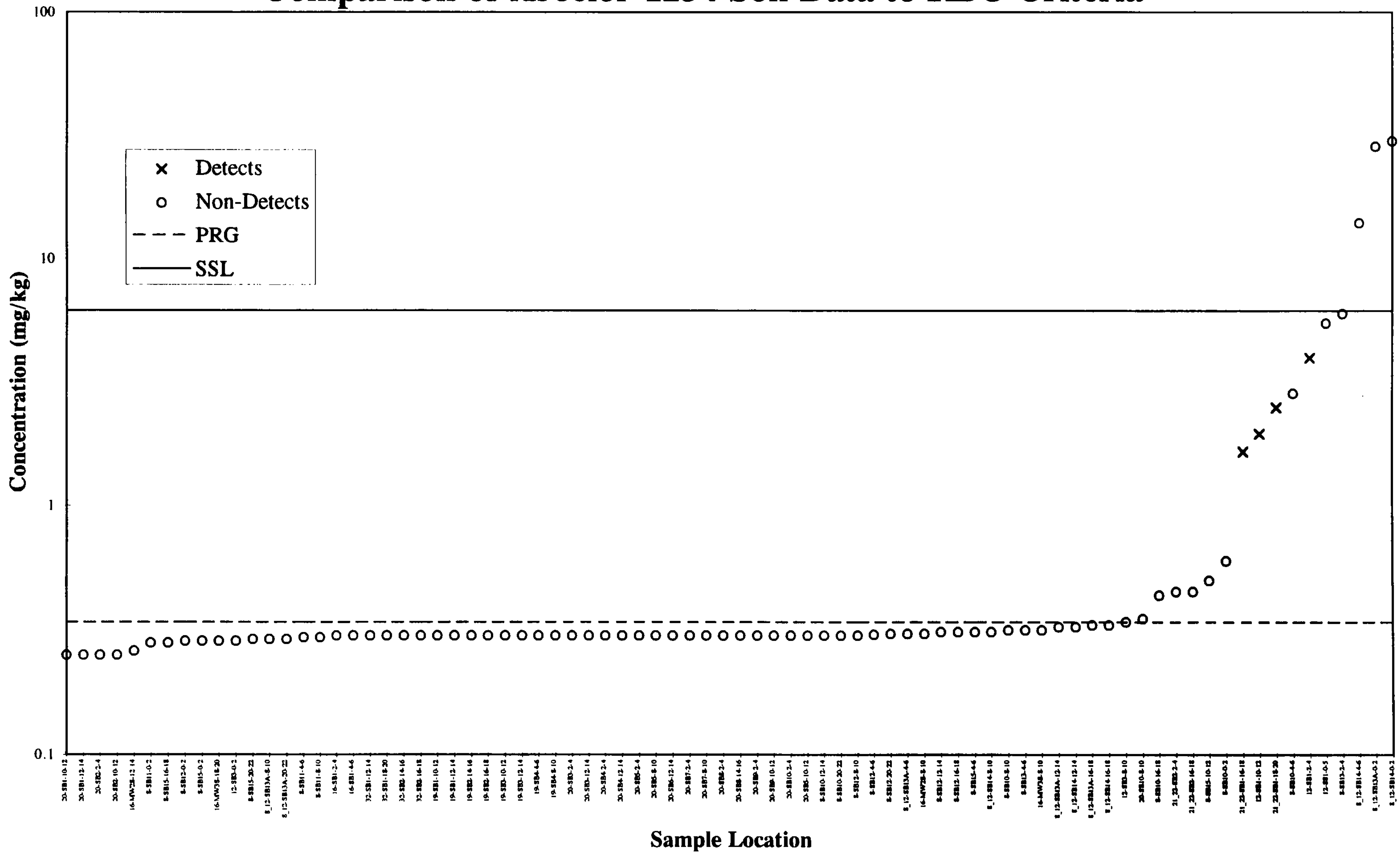

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Figure 4-4
Comparison of Aroclor-1260 Soil Data to RBC Criteria

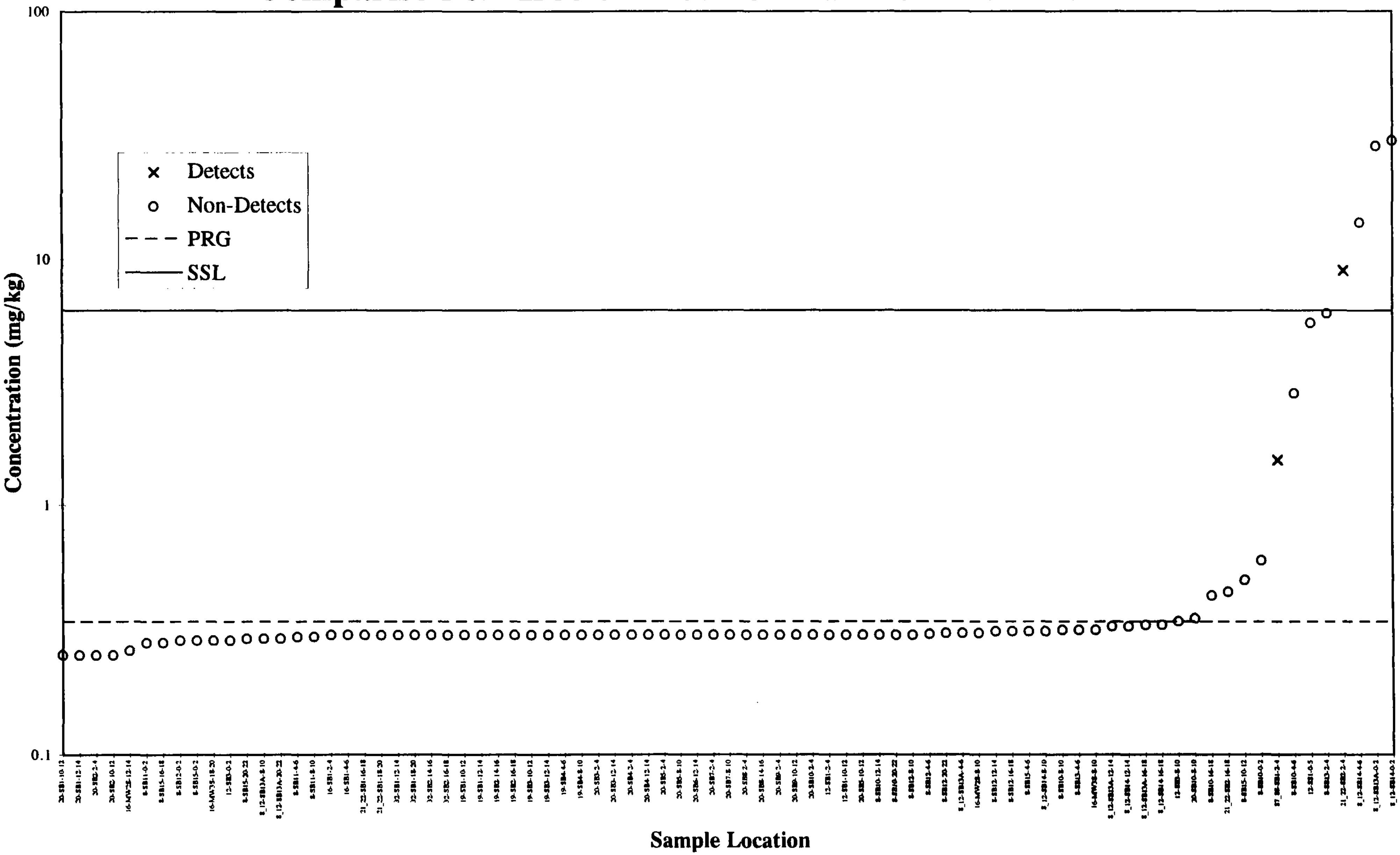

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Figure 4-5
Comparison of Arsenic Soil Data to RBC Criteria

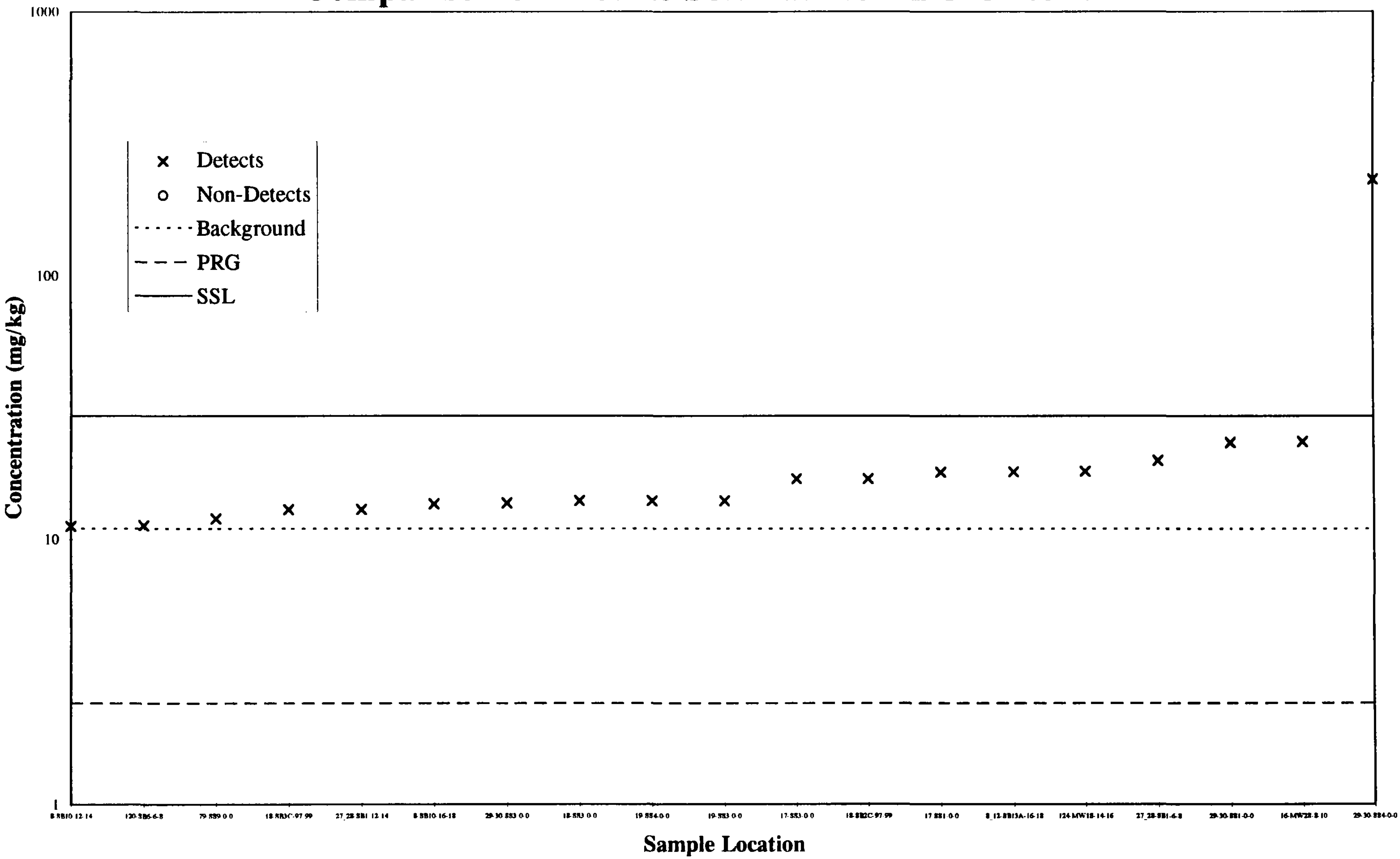

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Figure 4-6
Comparison of Benzene Soil Data to RBC Criteria

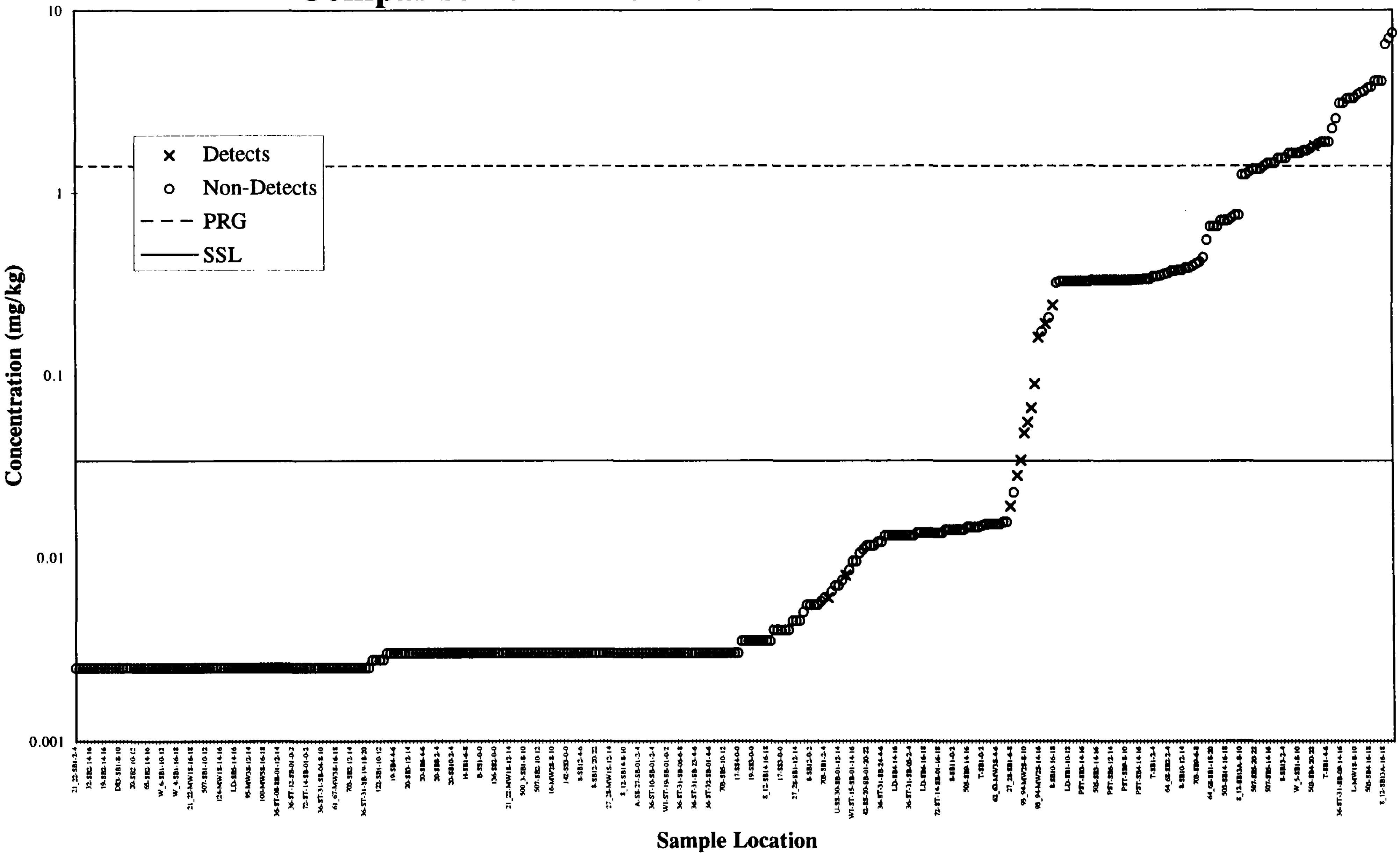

Figure 4-7
Comparison of Benzo(a)Pyrene Soil Data to RBC Criteria

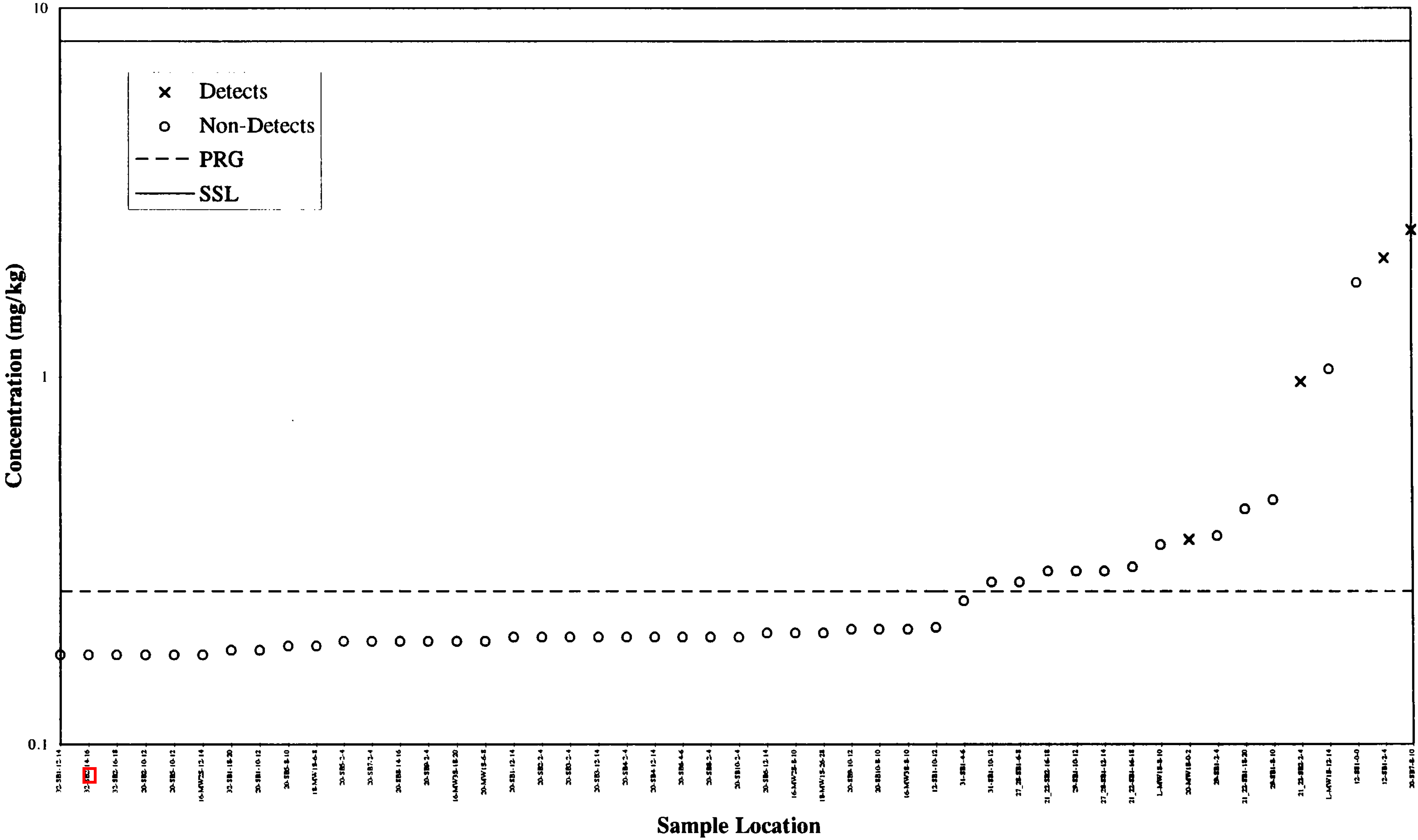

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Figure 4-8
Comparison of Benzo(b)Fluoranthene Soil Data to RBC Criteria

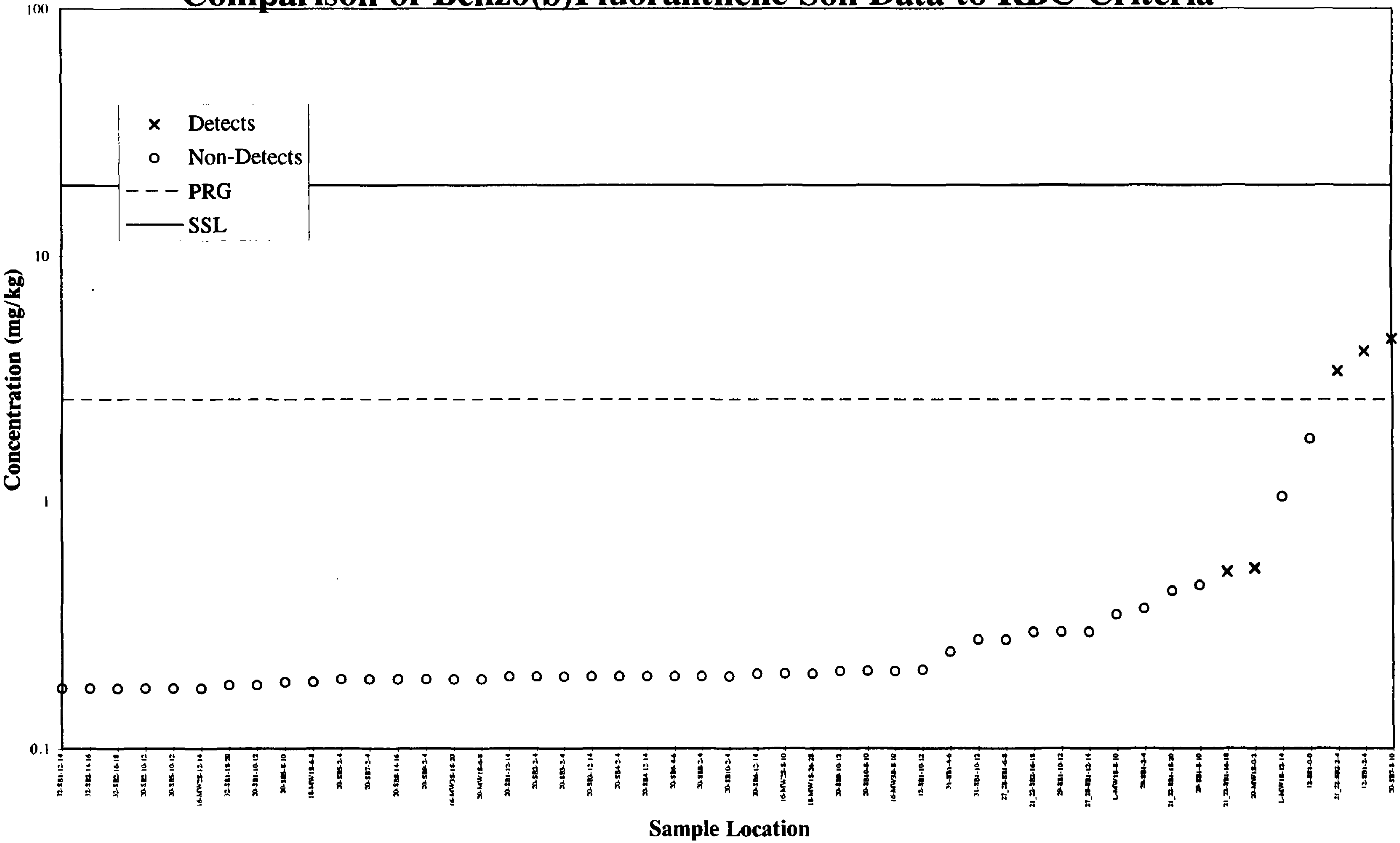

Figure 4-9
Comparison of Beryllium Soil Data to RBC Criteria

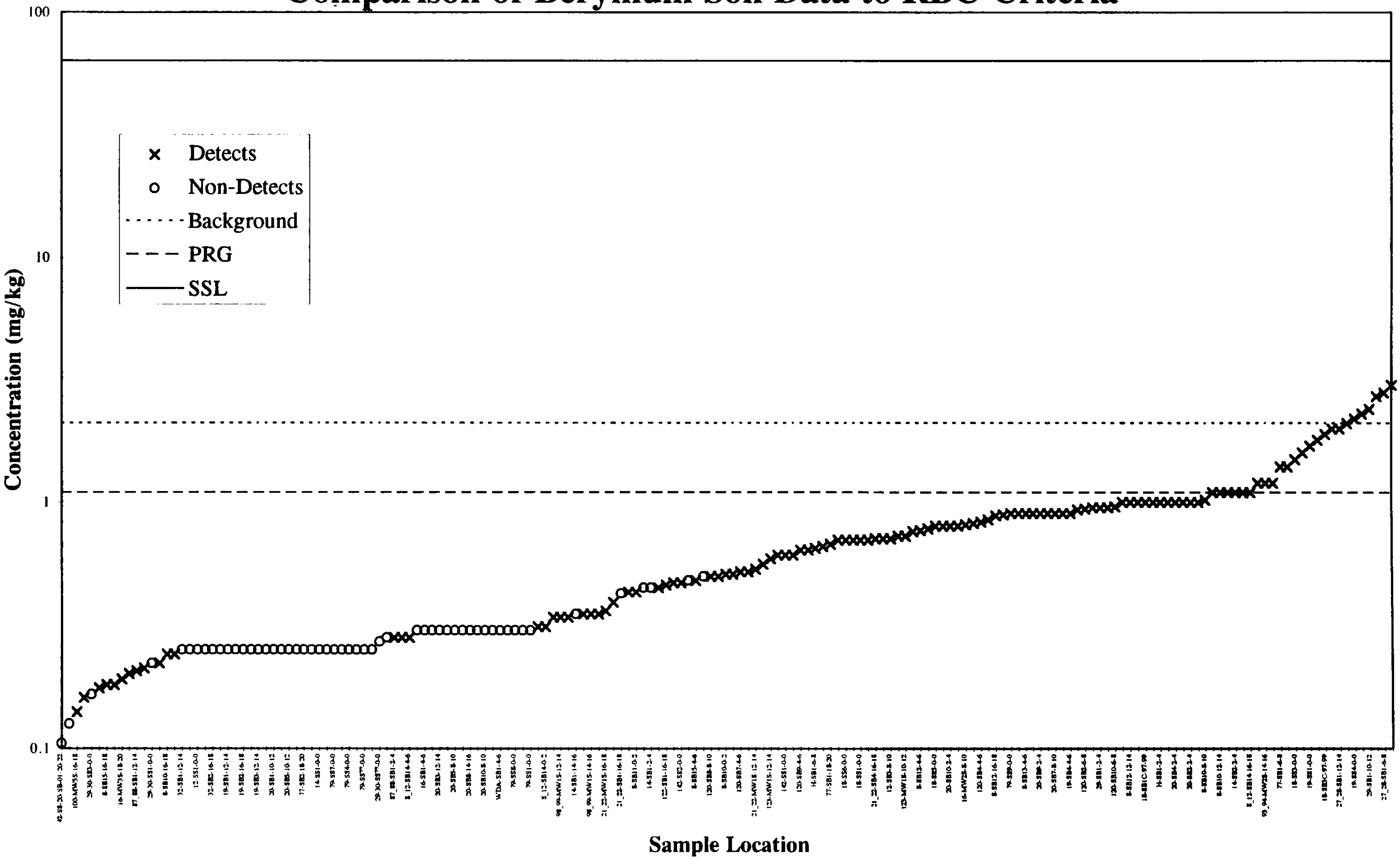

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Figure 4-10
Comparison of Cadmium Soil Data to RBC Criteria

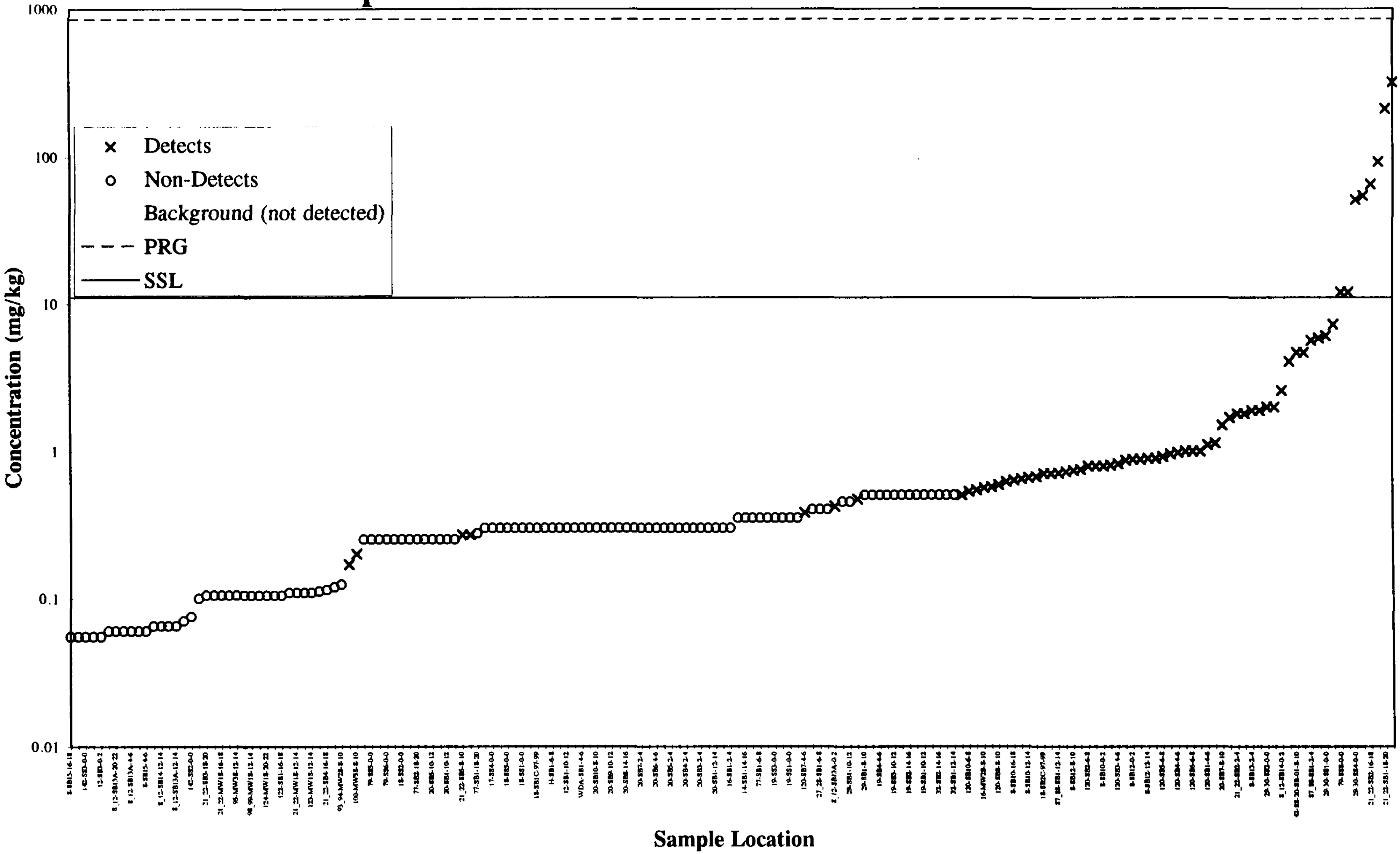

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Figure 4-11
Comparison of Calcium Soil Data to RBC Criteria

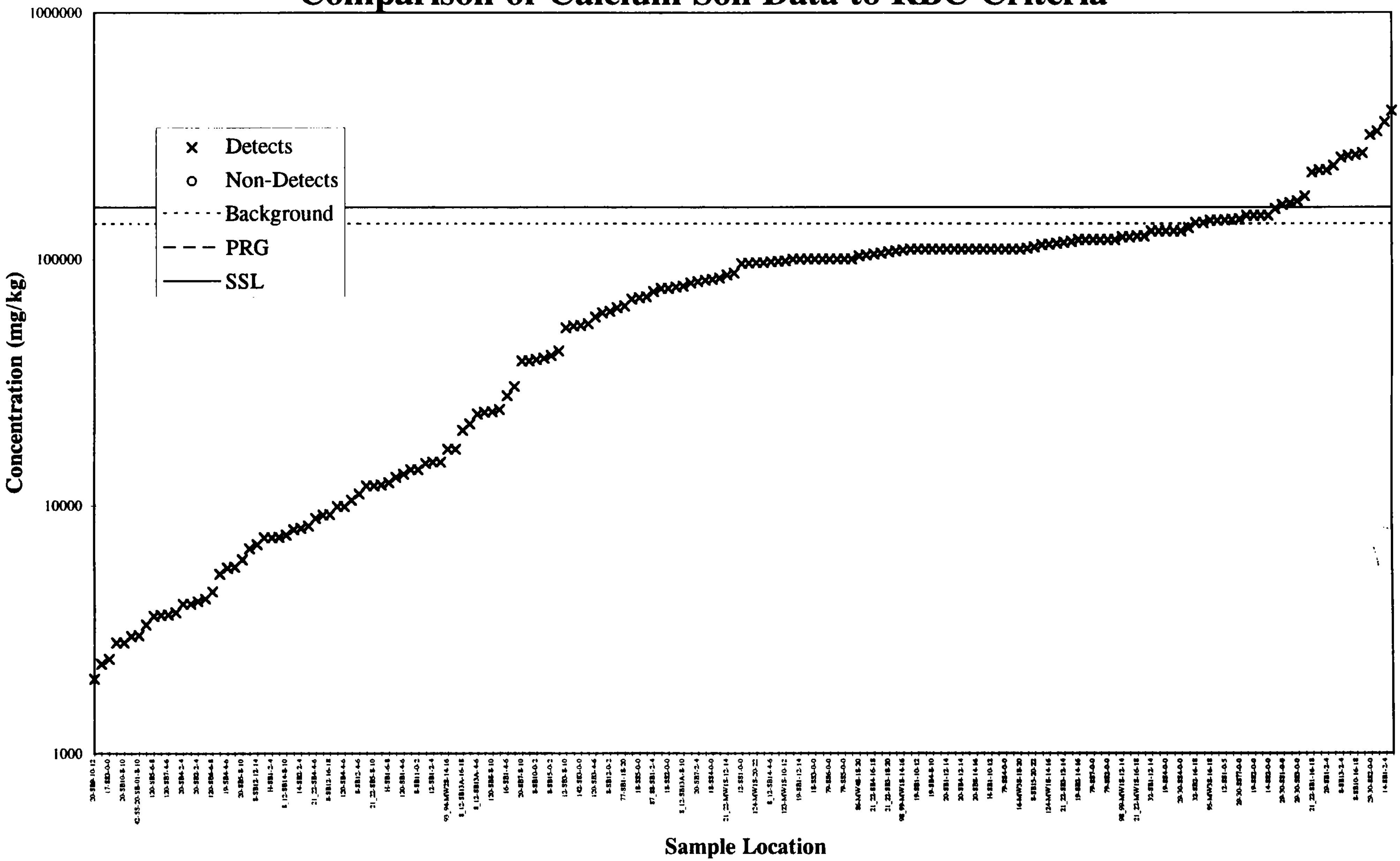

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Figure 4-12
Comparison of Copper Soil Data to RBC Criteria

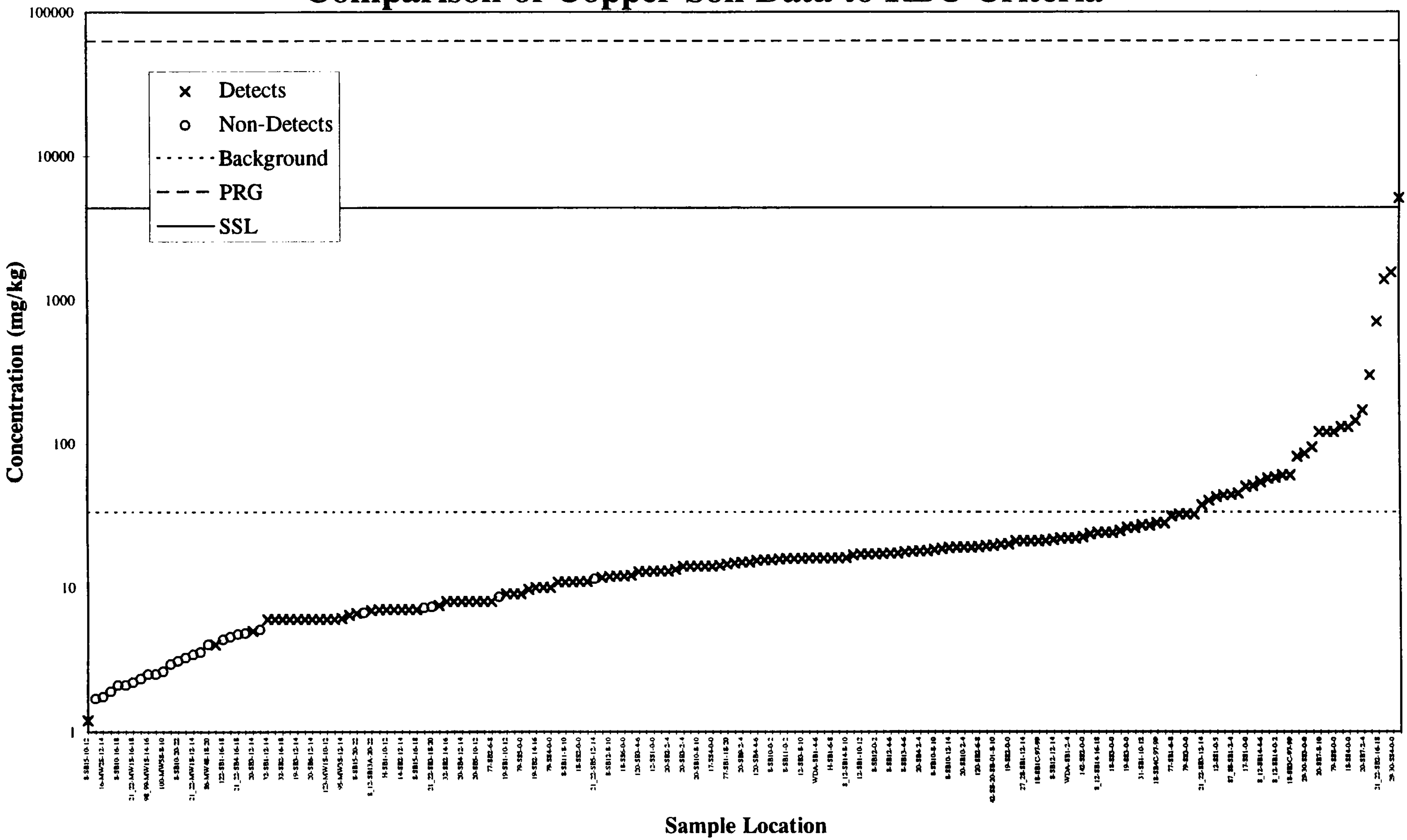

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Figure 4-13
Comparison of Cyanide Soil Data to RBC Criteria

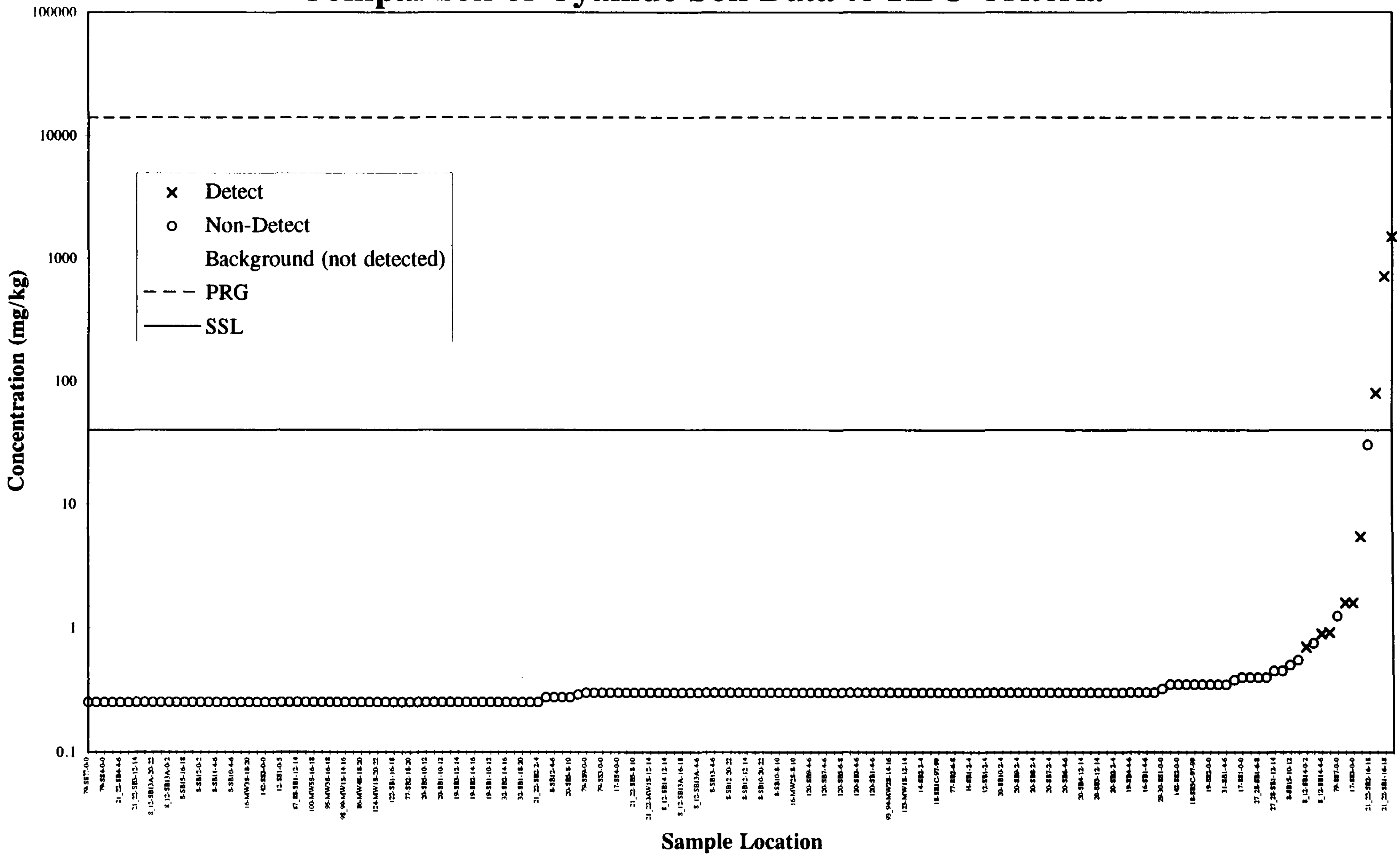

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Figure 4-14
Comparison of 1,2-Dichloroethene Soil Data to RBC Criteria

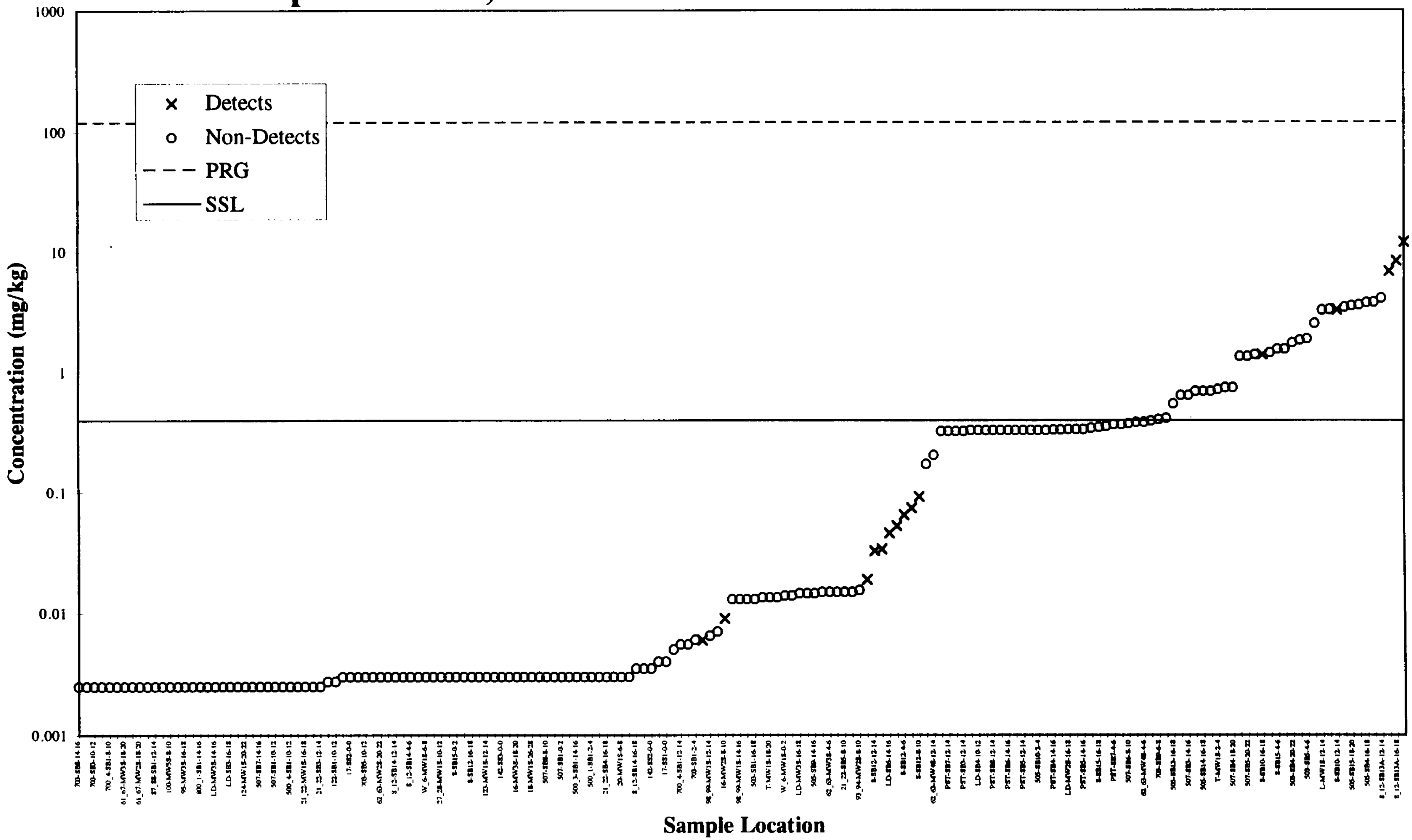

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Figure 4-15
Comparison of Cis-1,2-Dichloroethene Soil Data to RBC Criteria

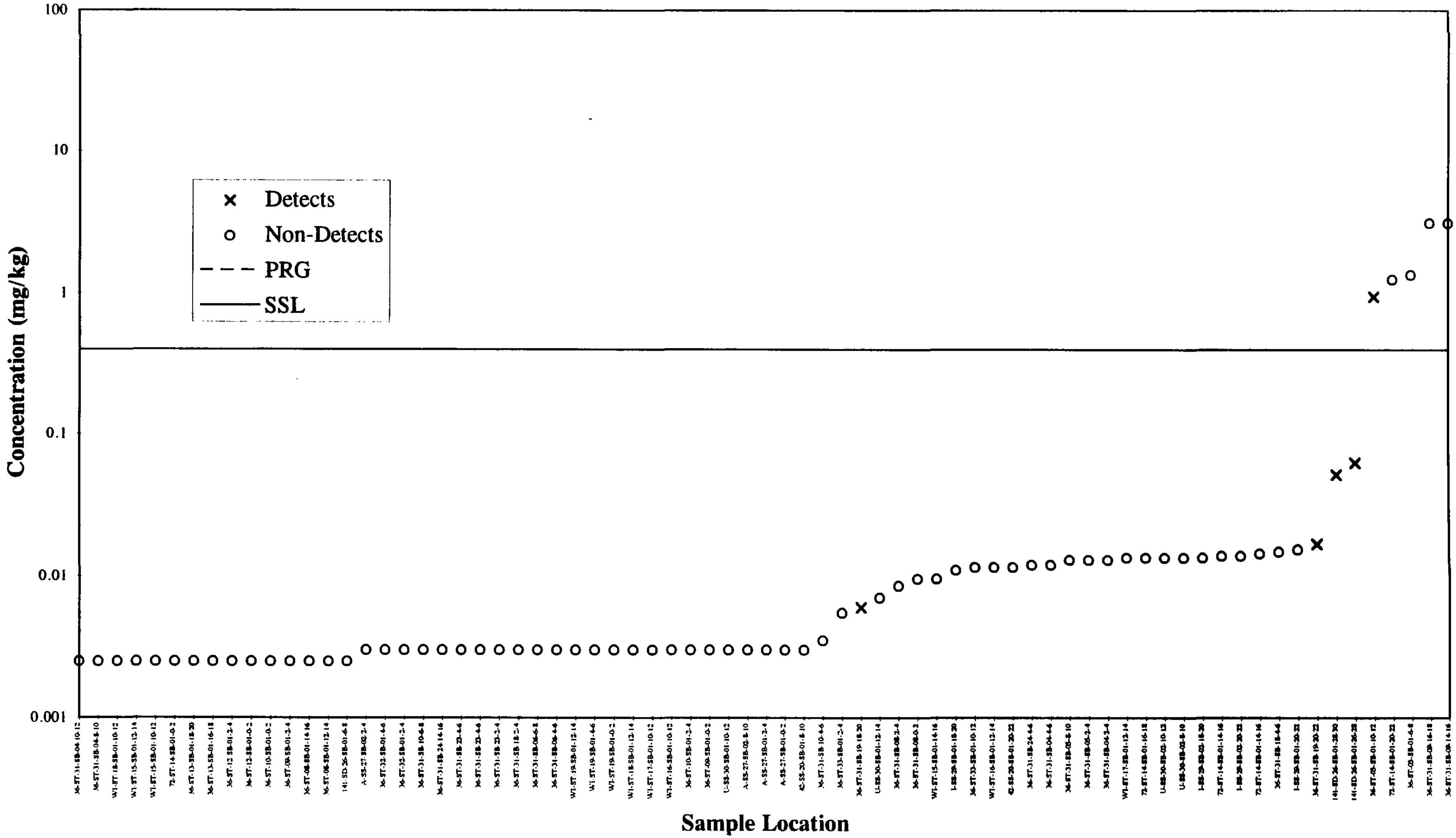

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Figure 4-16
Comparison of Ethylbenzene Soil Data to RBC Criteria

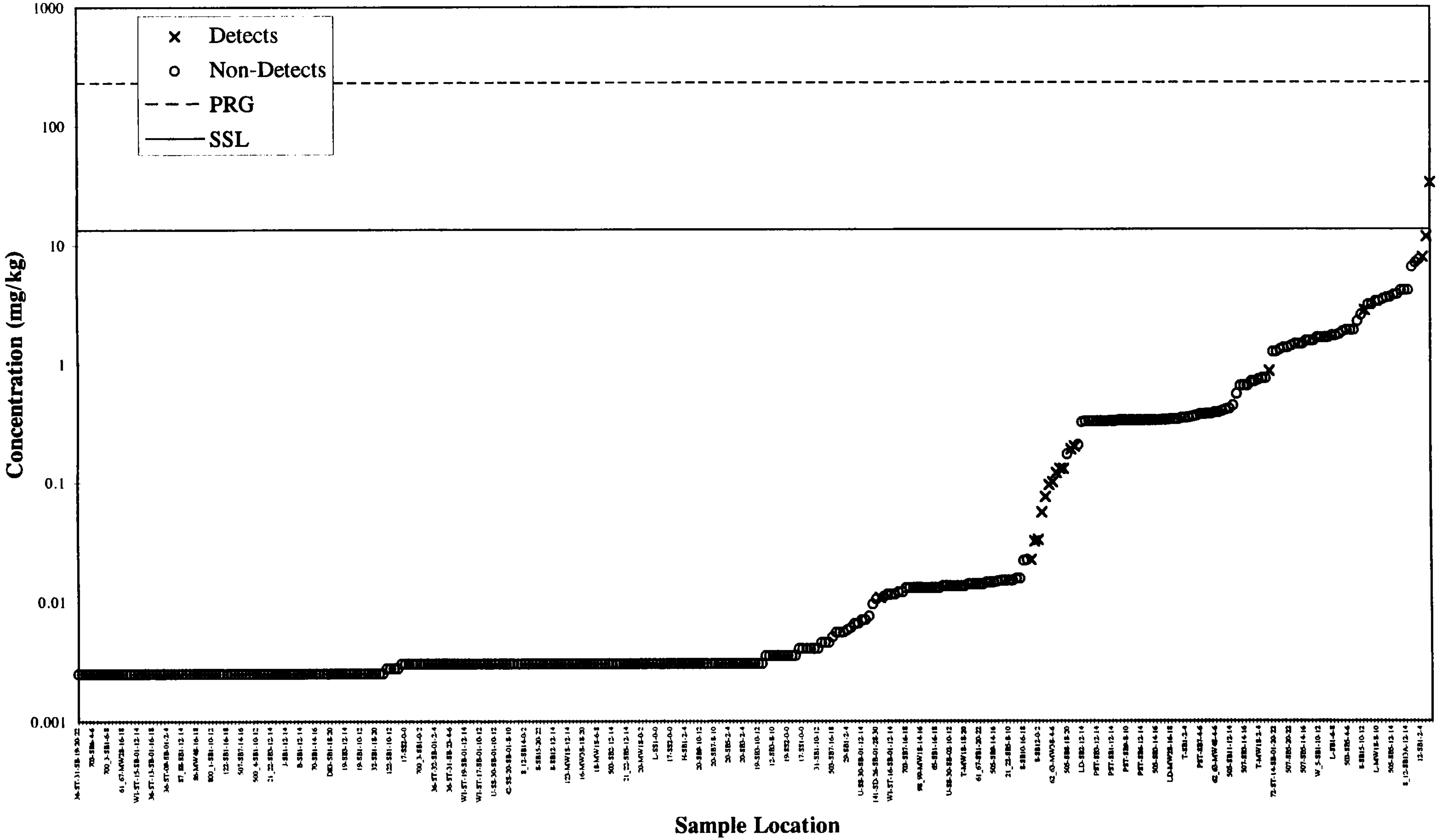

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Figure 4-17
Comparison of Lead Soil Data to RBC Criteria

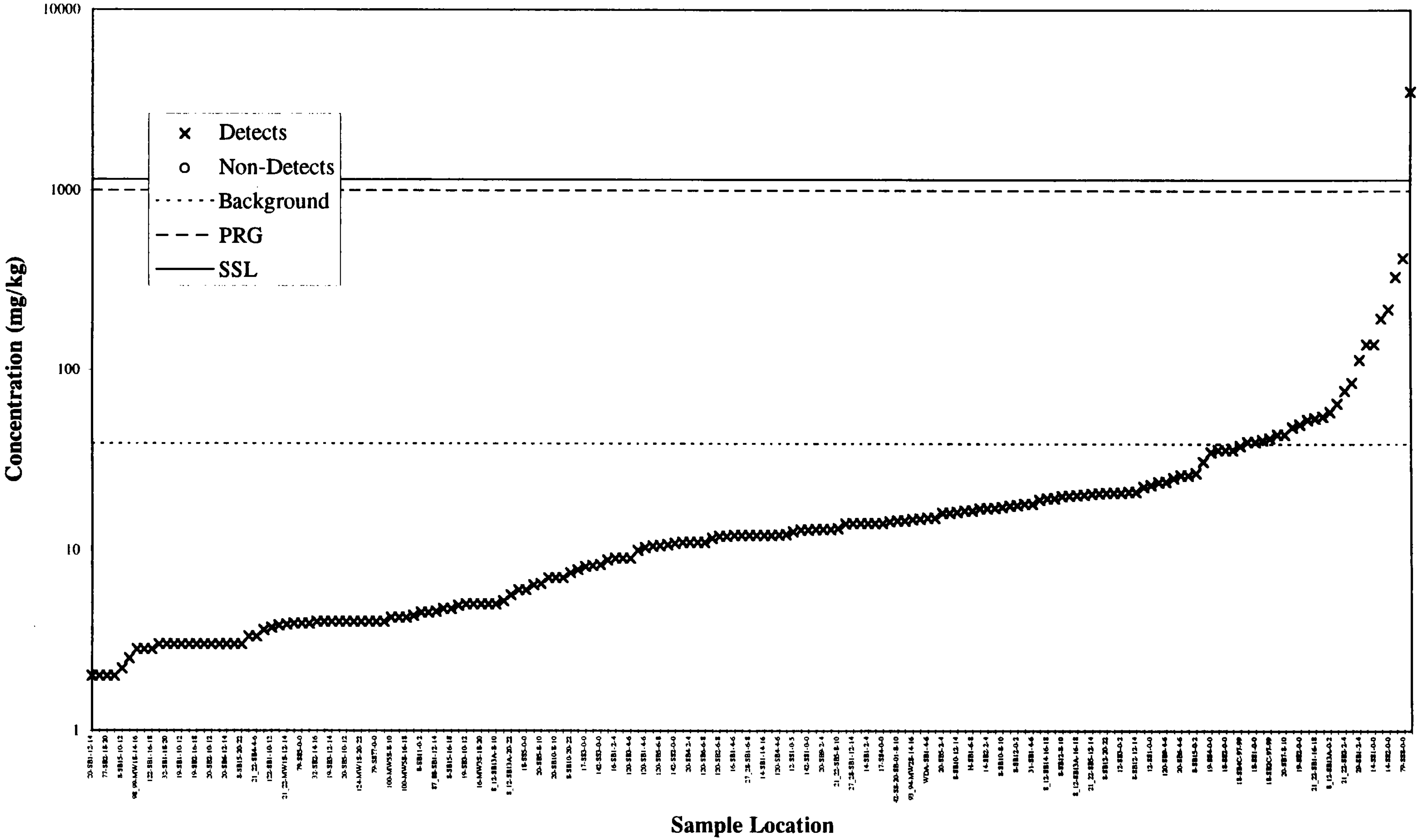

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Figure 4-18
Comparison of Manganese Soil Data to RBC Criteria

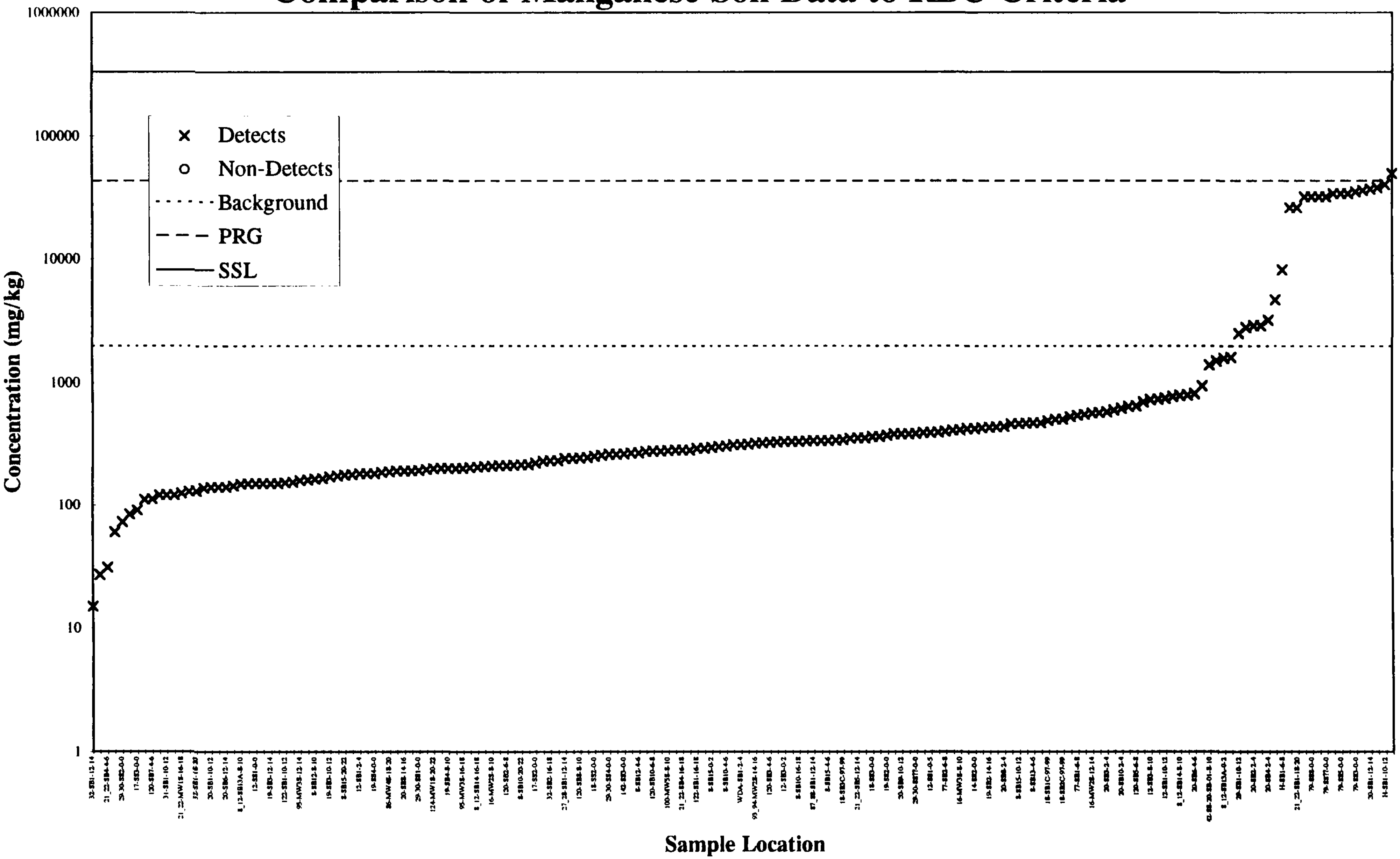

Figure 4-19
Comparison of Mercury Soil Data to RBC Criteria

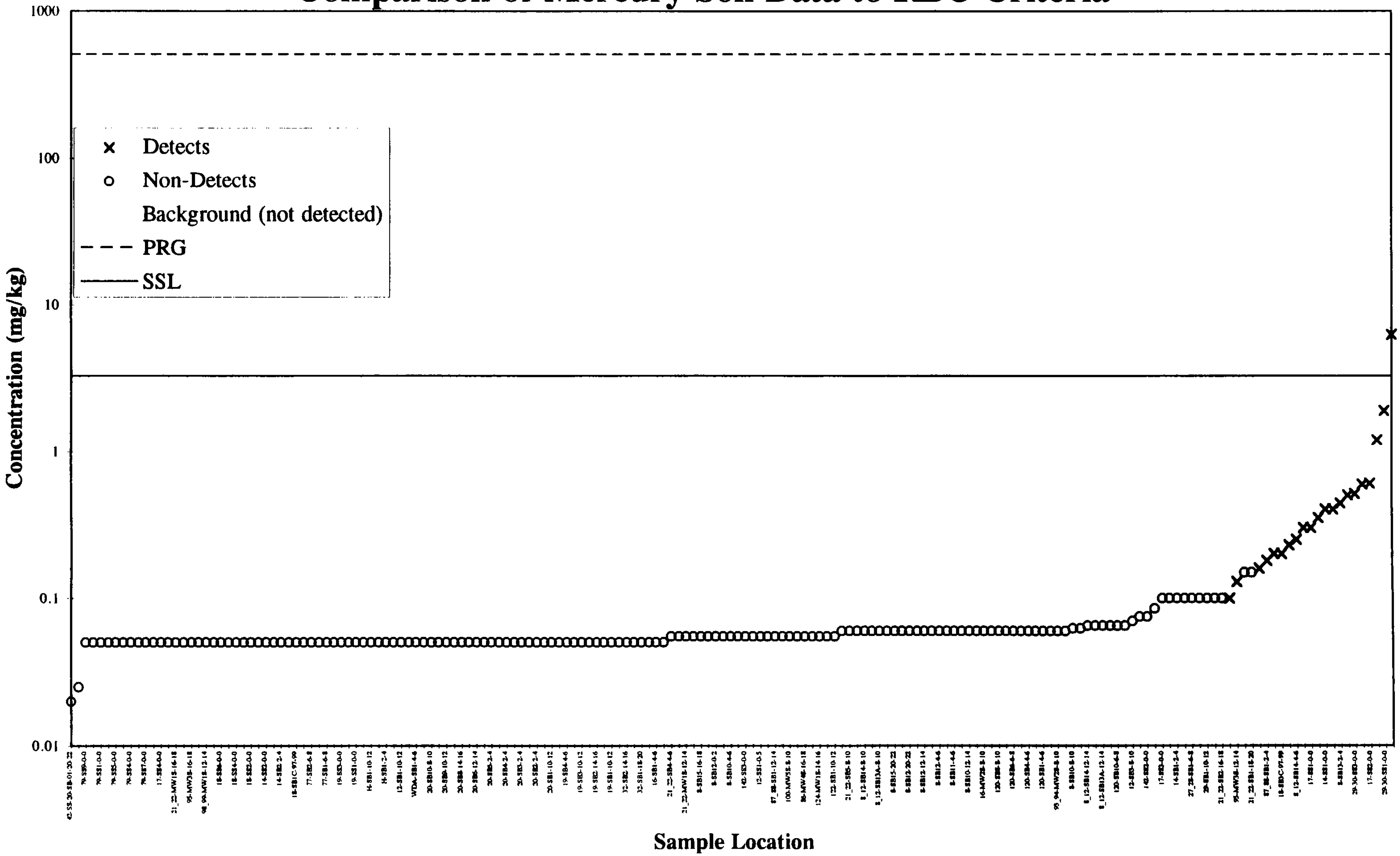

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Figure 4-20
Comparison of Methylene Chloride Soil Data to RBC Criteria

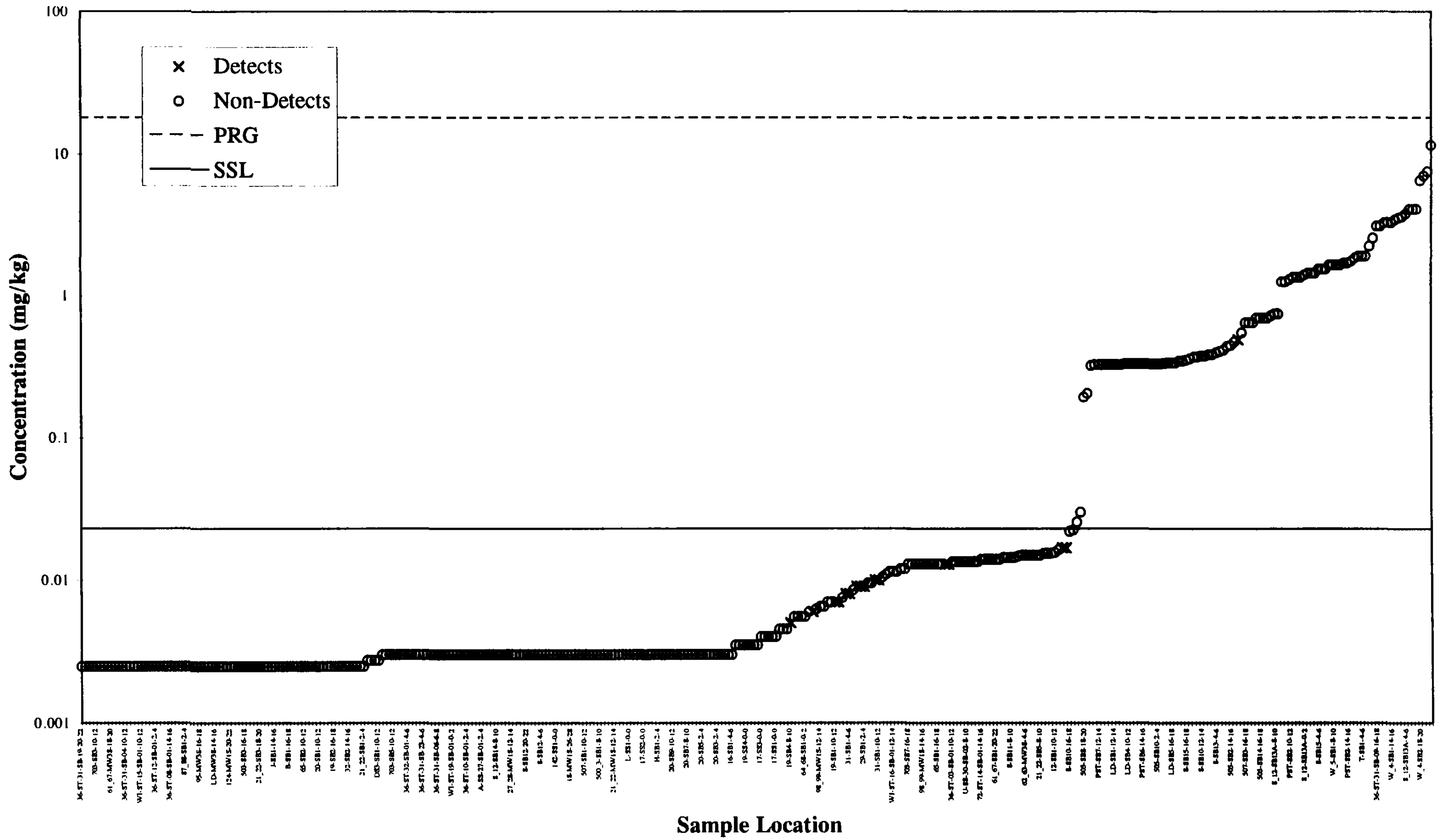

Figure 4-21
Comparison of Nickel Soil Data to RBC Criteria

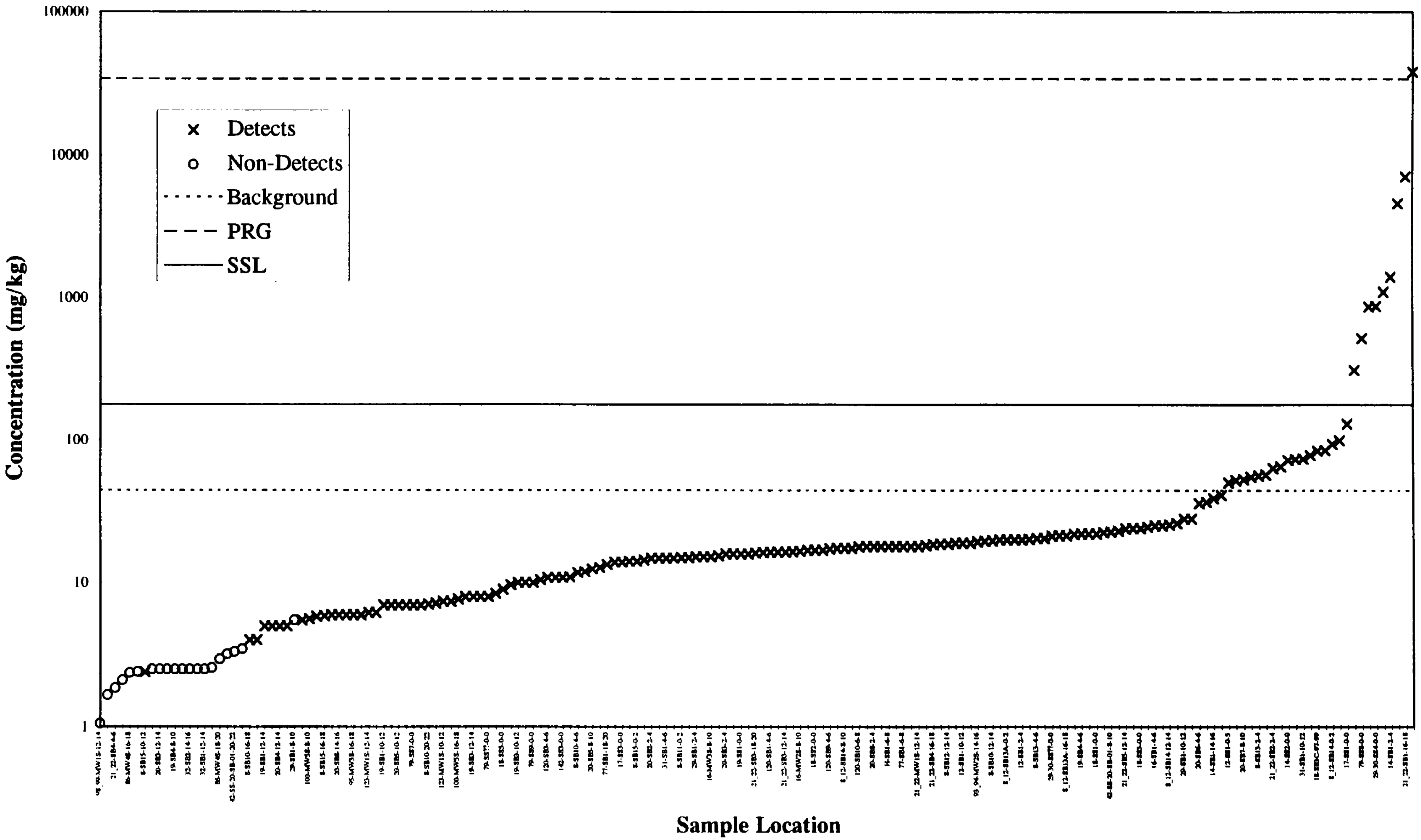

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Figure 4-22

Comparison of Tetrachloroethene Soil Data to RBC Criteria

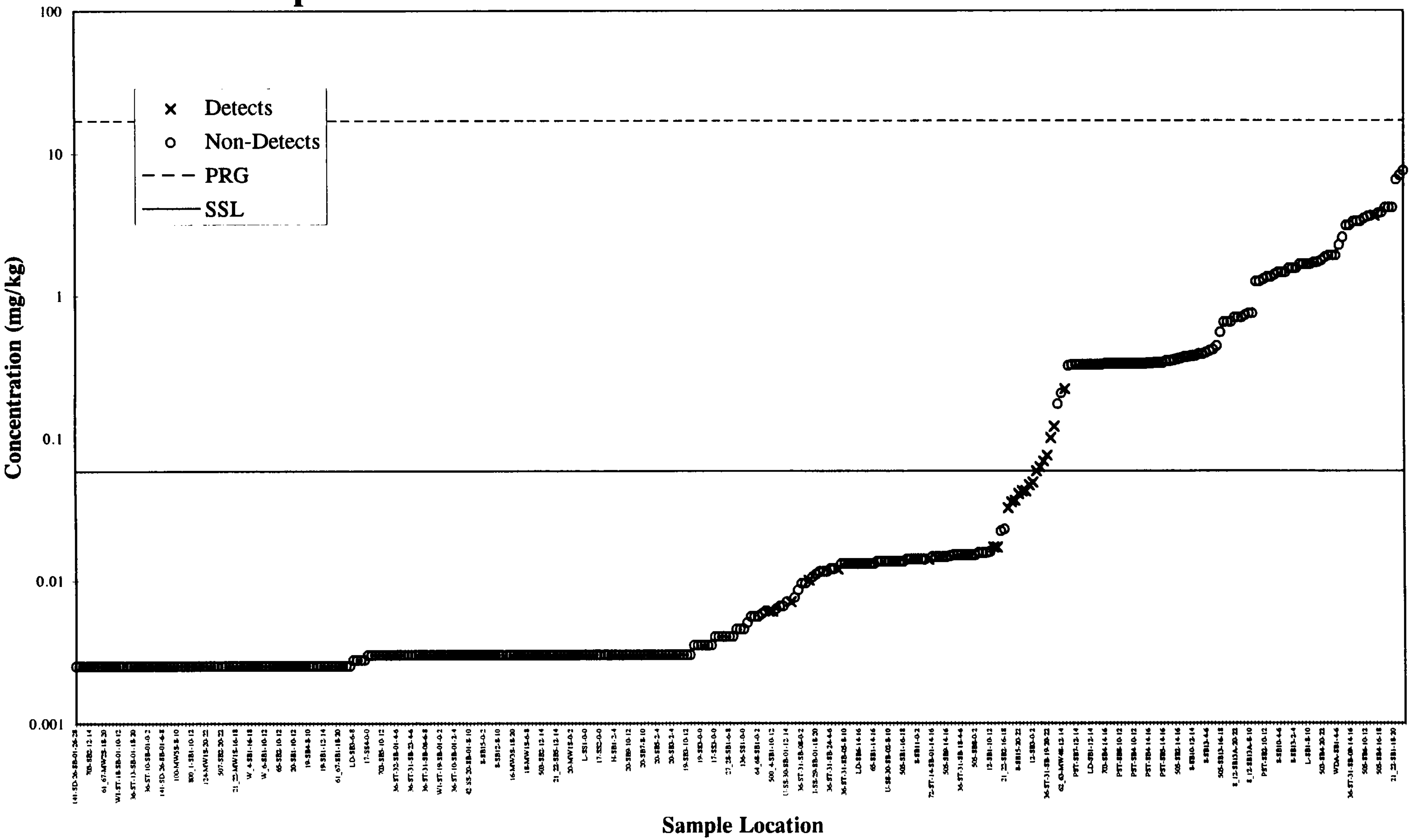

Figure 4-23
Comparison of Toluene Soil Data to RBC Criteria

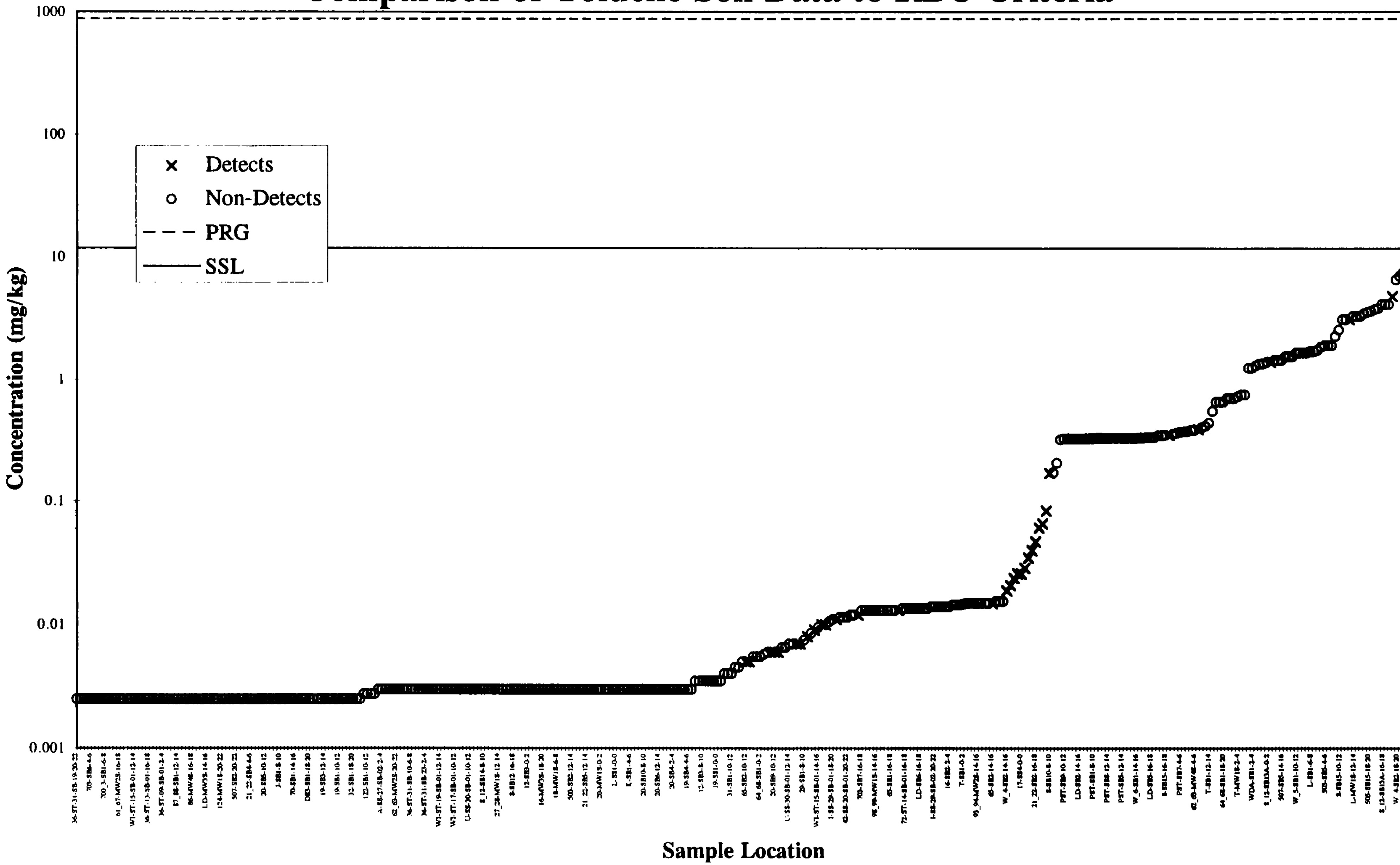

Figure 4-24
Total Petroleum Hydrocarbon Soil RBC Data

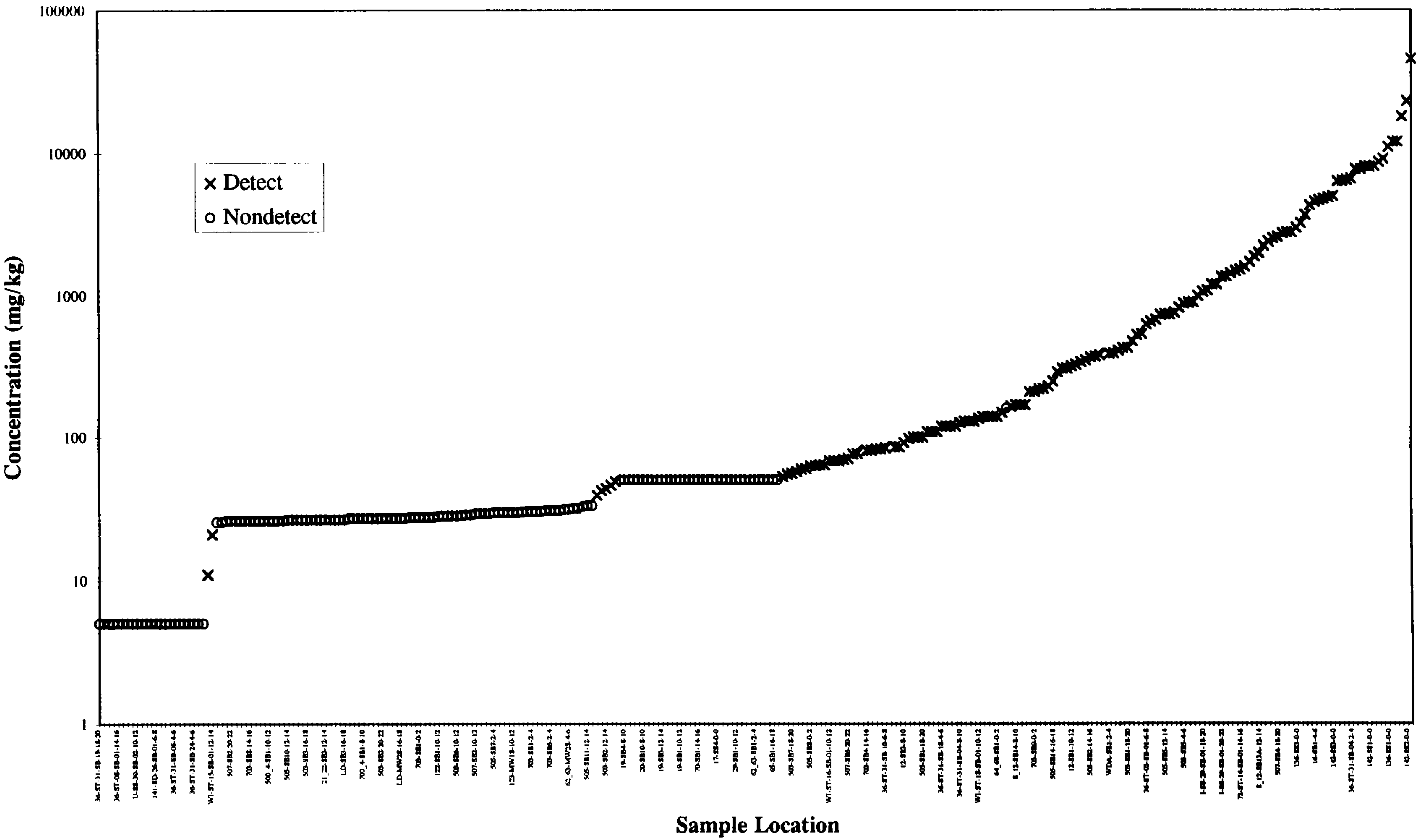

Figure 4-25
Comparison of Trichloroethene Soil Data to RBC Criteria

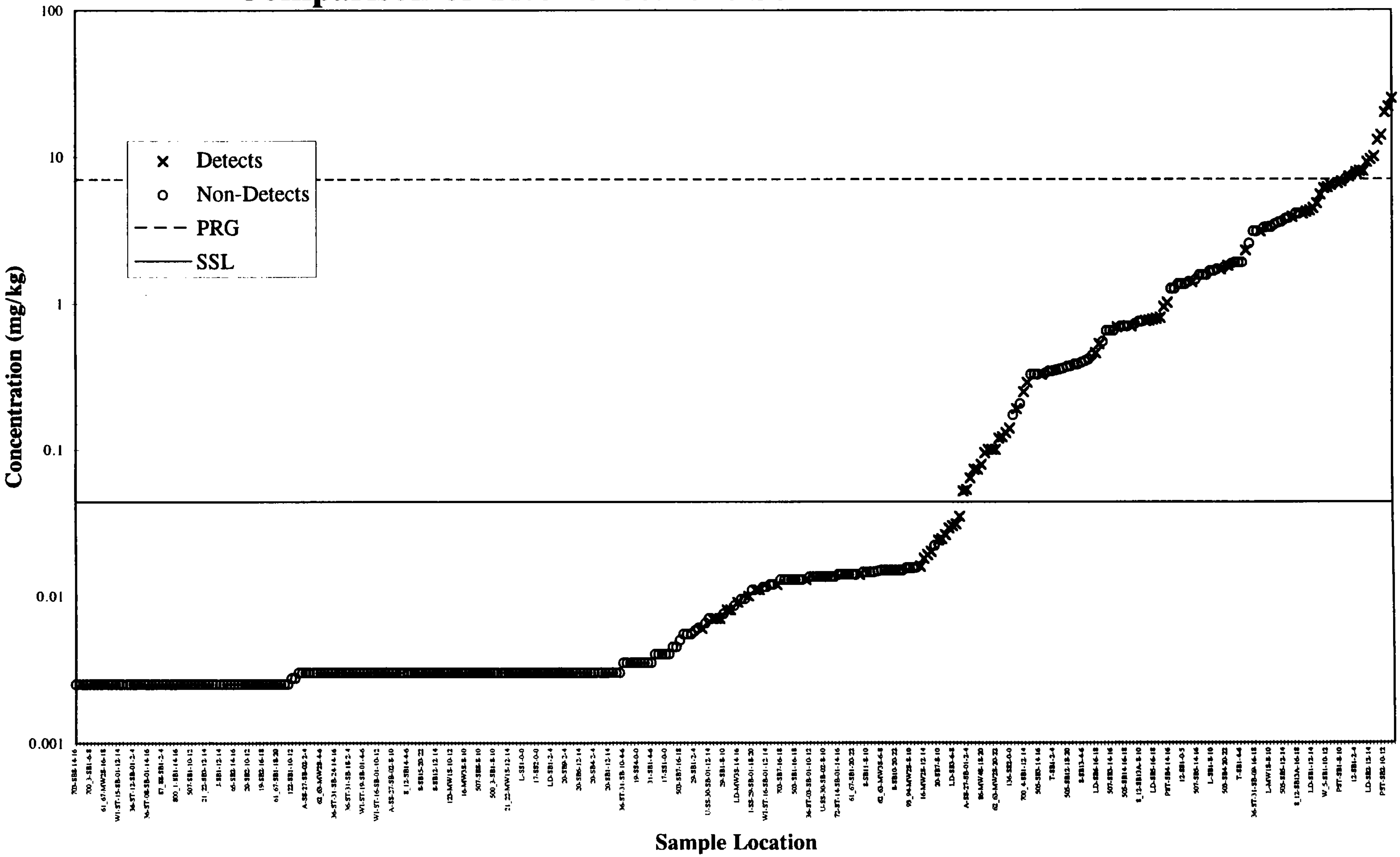

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Figure 4-26
Comparison of Vinyl Chloride Soil Data to RBC Criteria

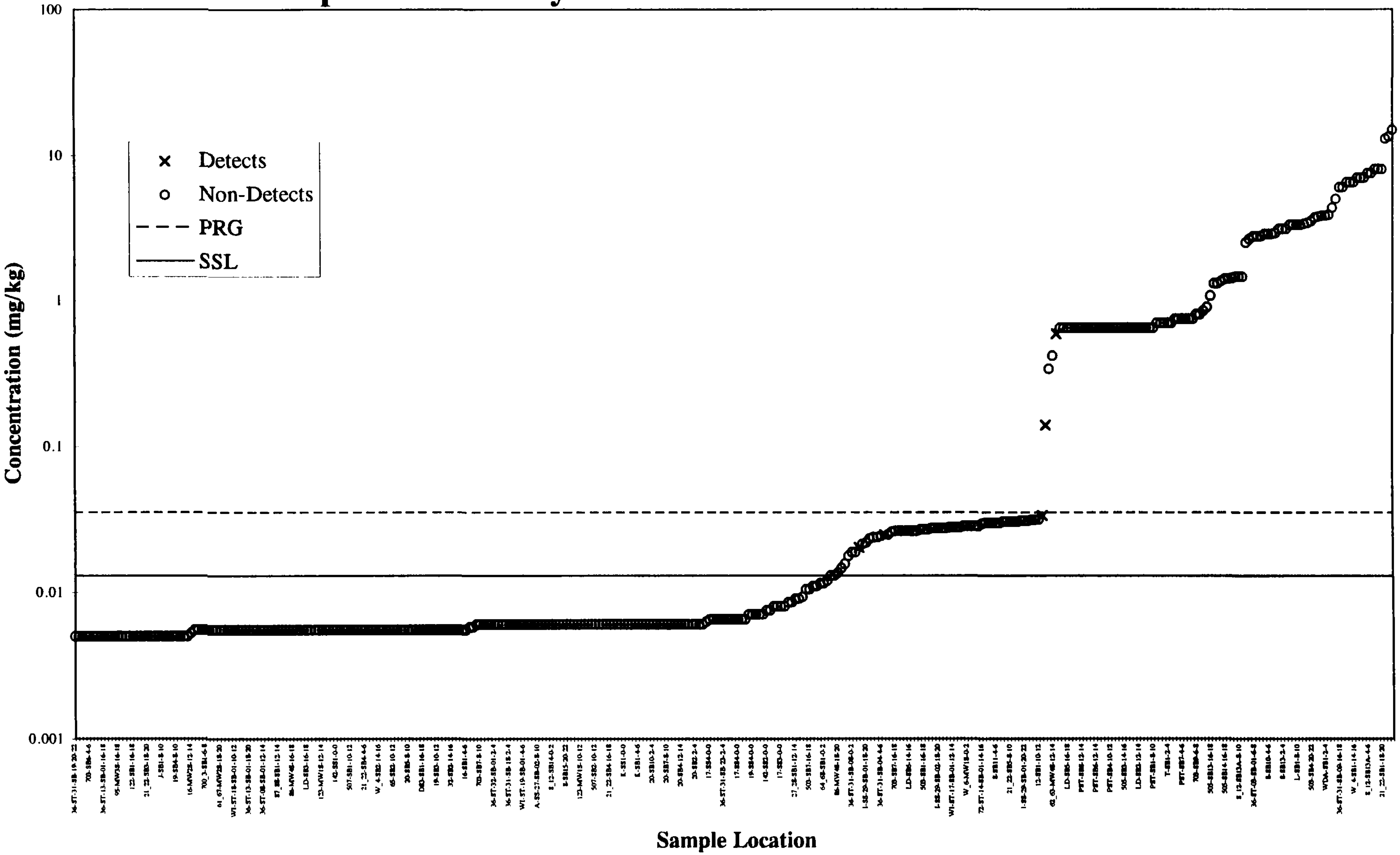

Figure 4-27
Comparison of Zinc Soil Data to RBC Criteria

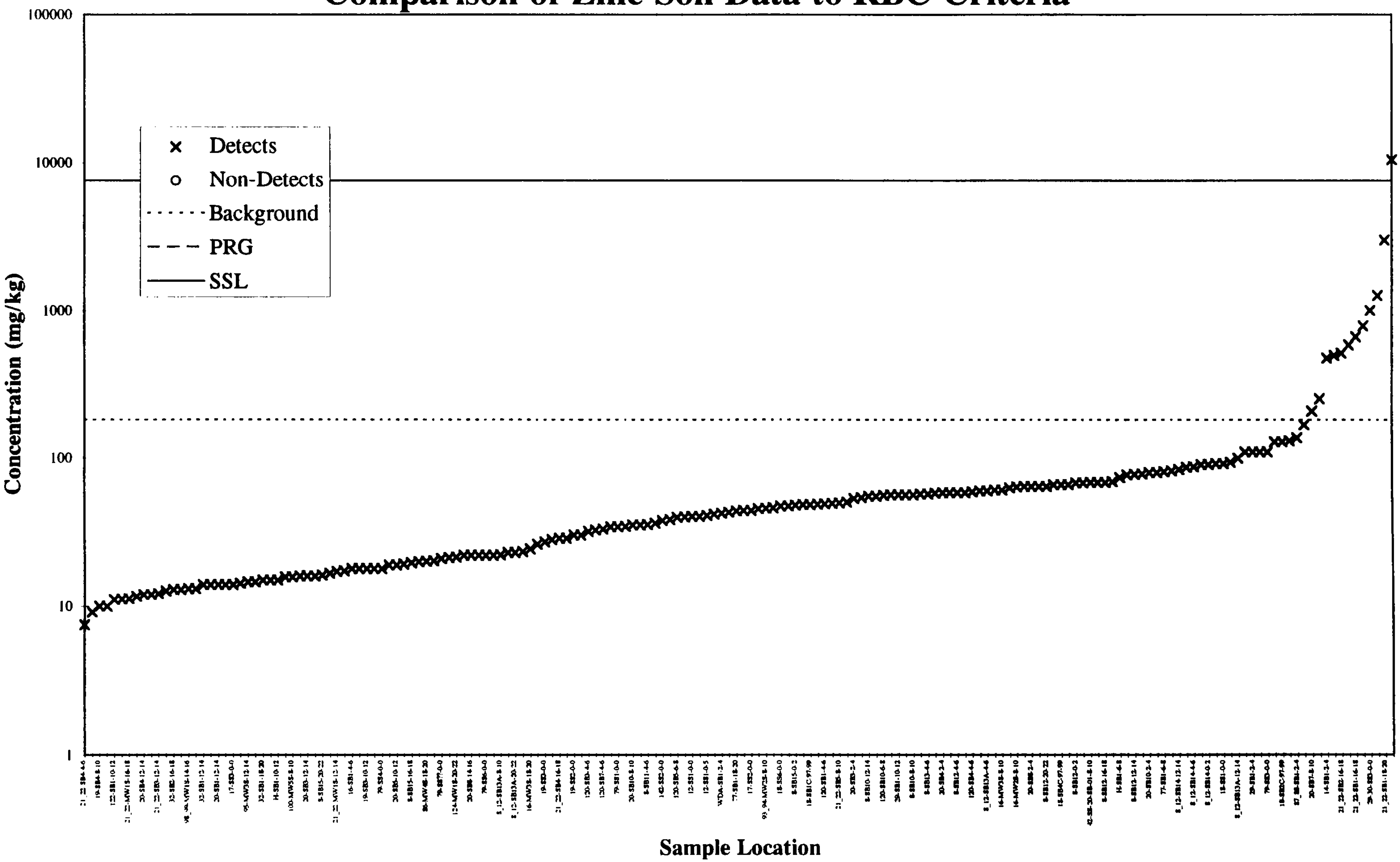

Figure 4-28
Comparison of Arsenic Sediment Data to RBC Criteria

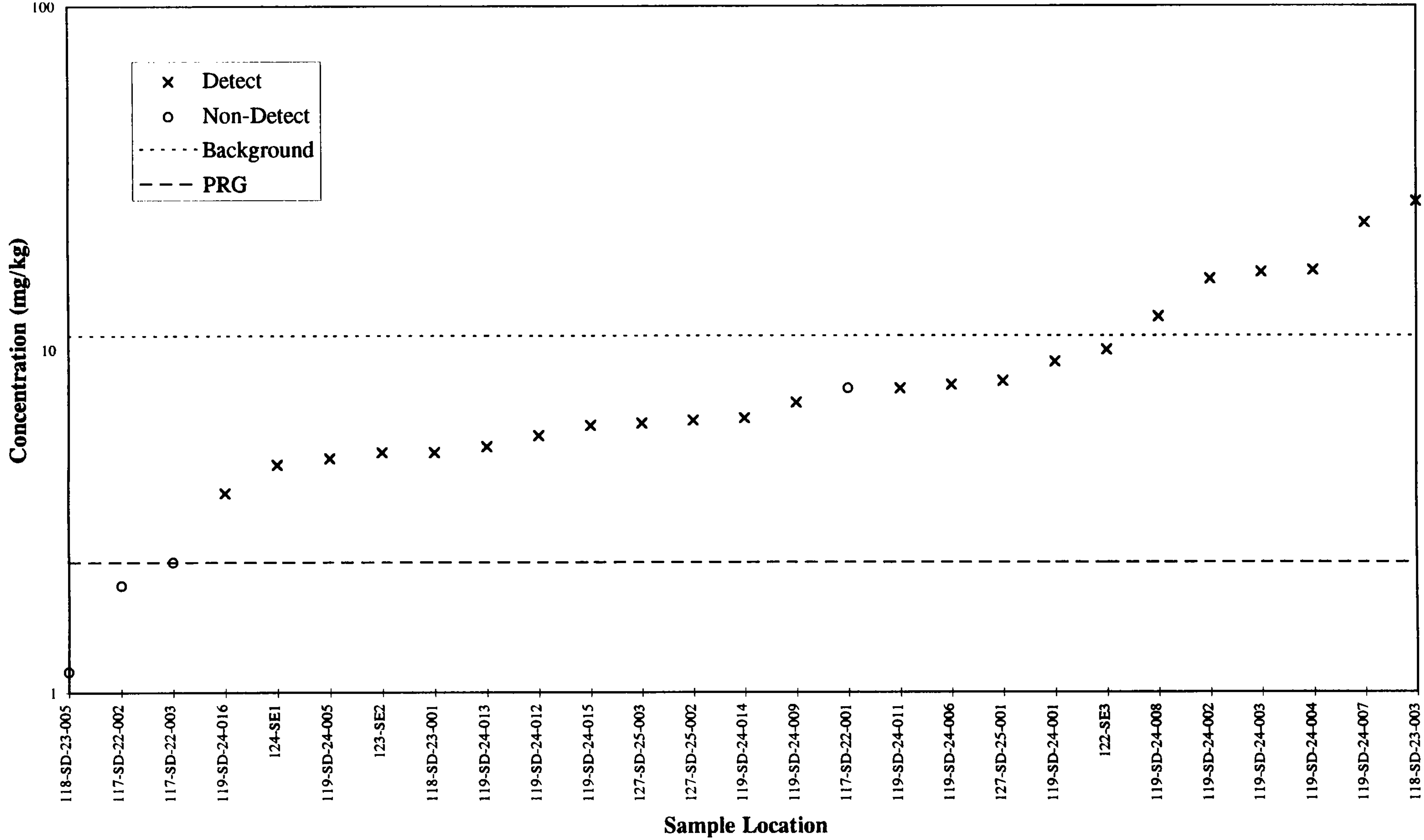

Figure 4-29
Comparison of Benzene Sediment Data to RBC Criteria

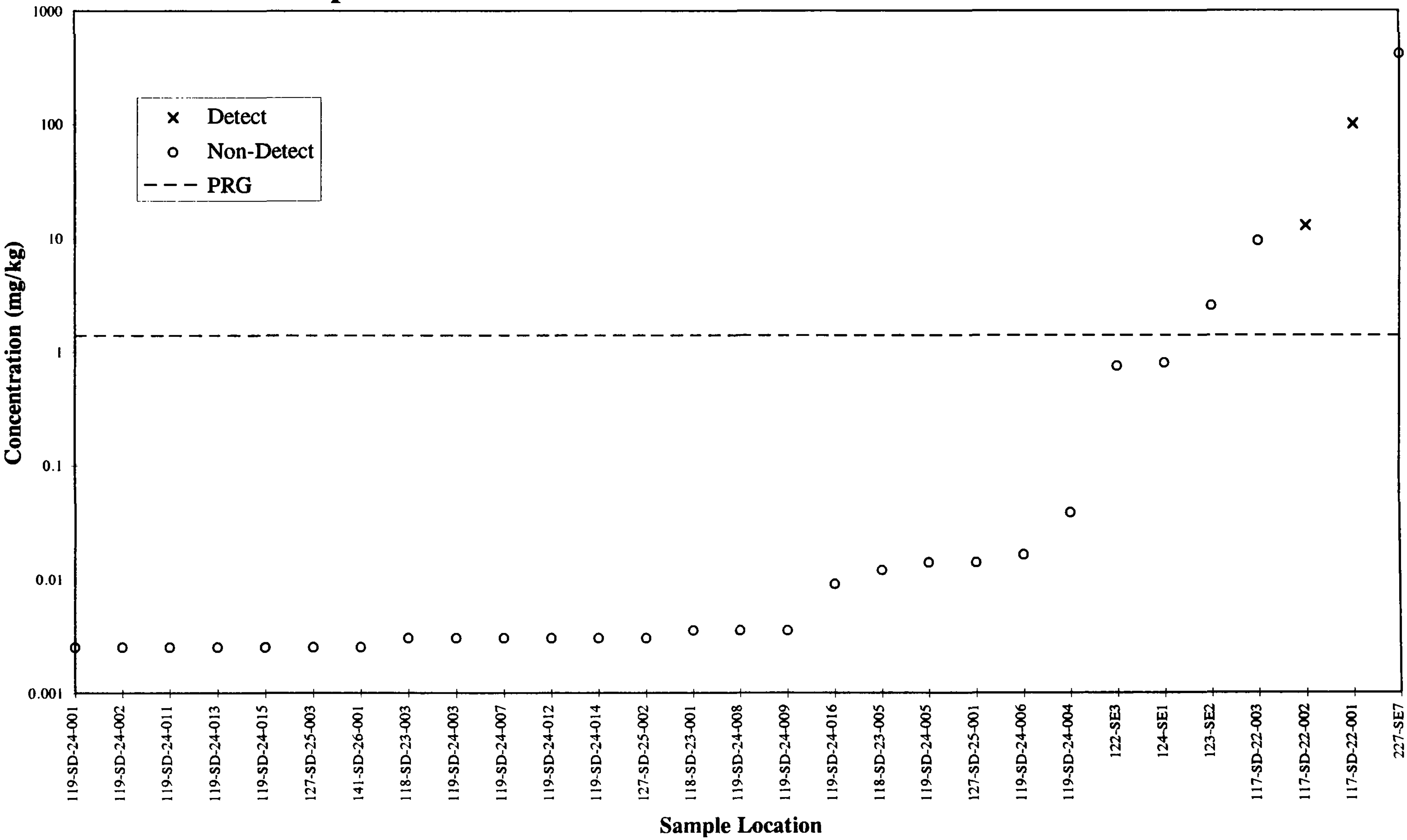

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Figure 4-30
Comparison of Lead Sediment Data to RBC Criteria

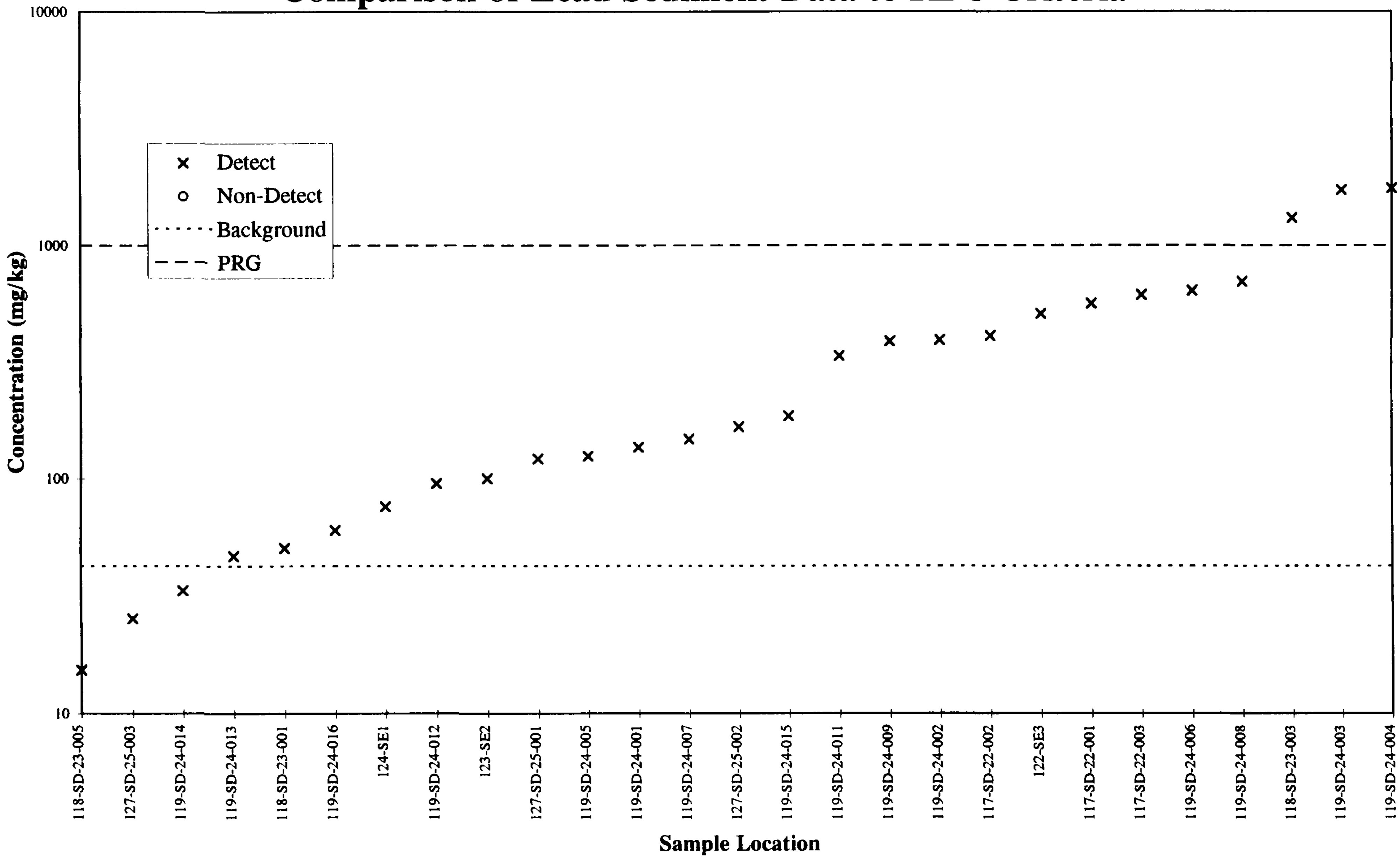

Figure 4-31
Comparison of Manganese Sediment Data to RBC Criteria

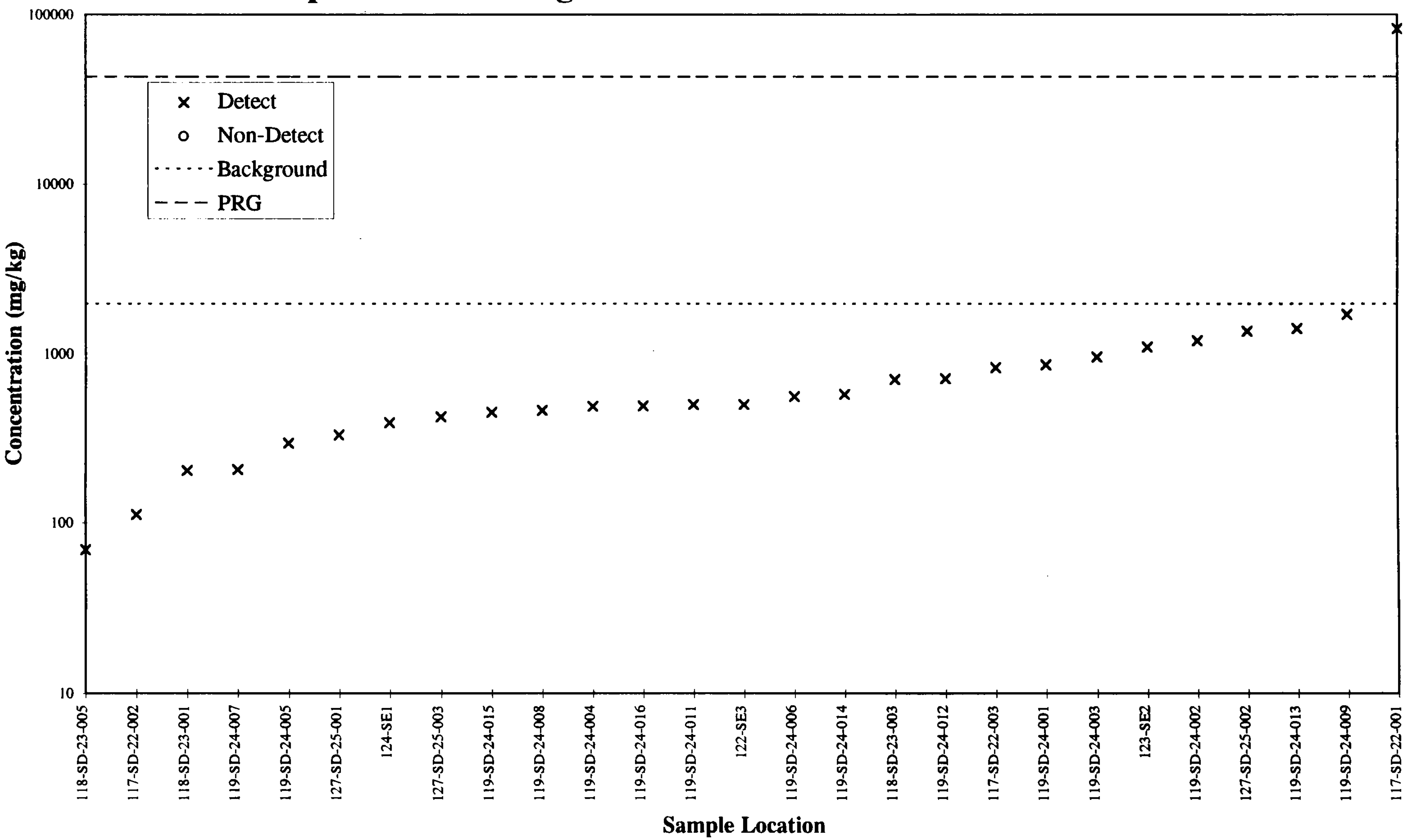

Figure 4-32
Comparison of Toluene Sediment Data to RBC Criteria

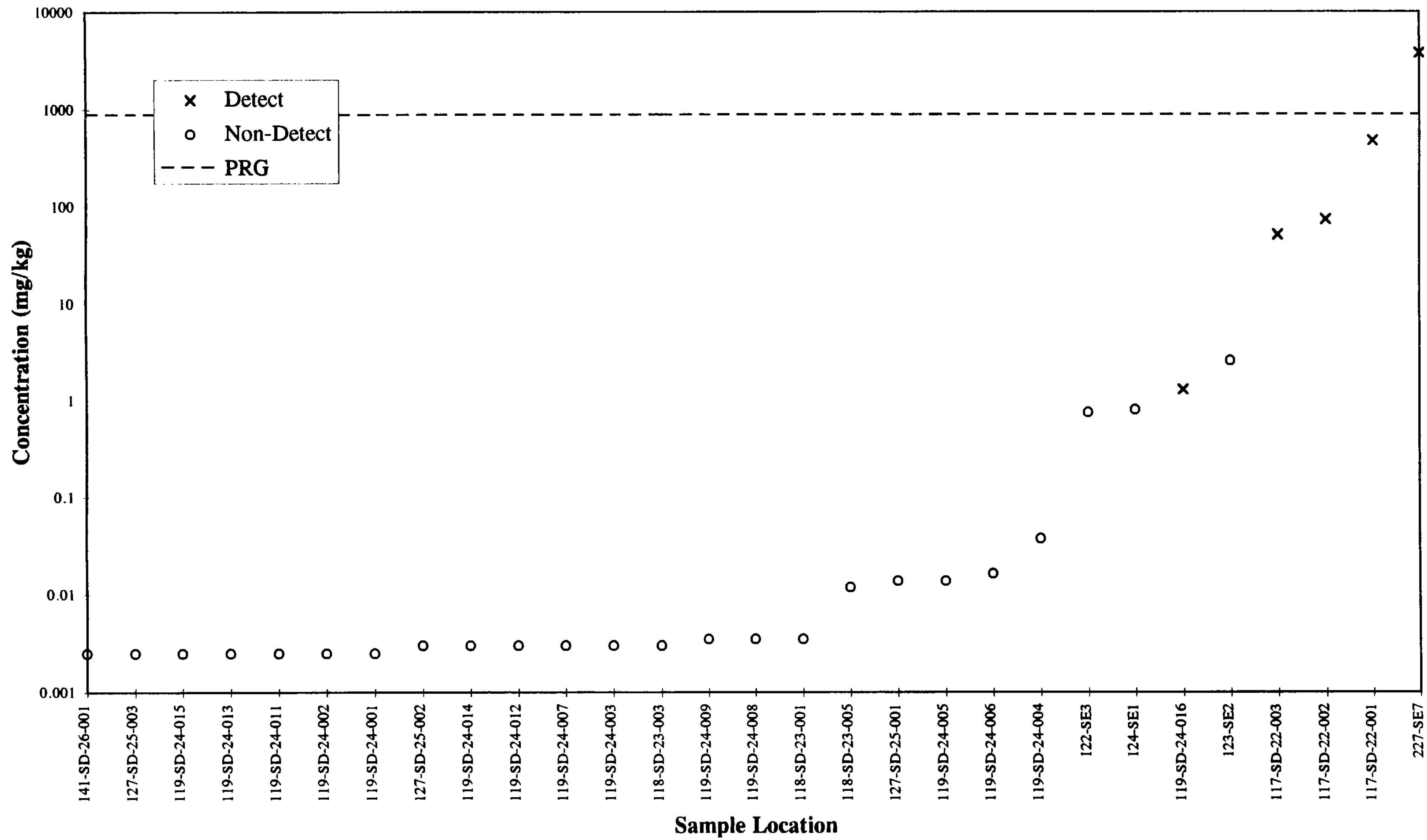

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Figure 4-33
Comparison of Xylenes Sediment Data to RBC Criteria

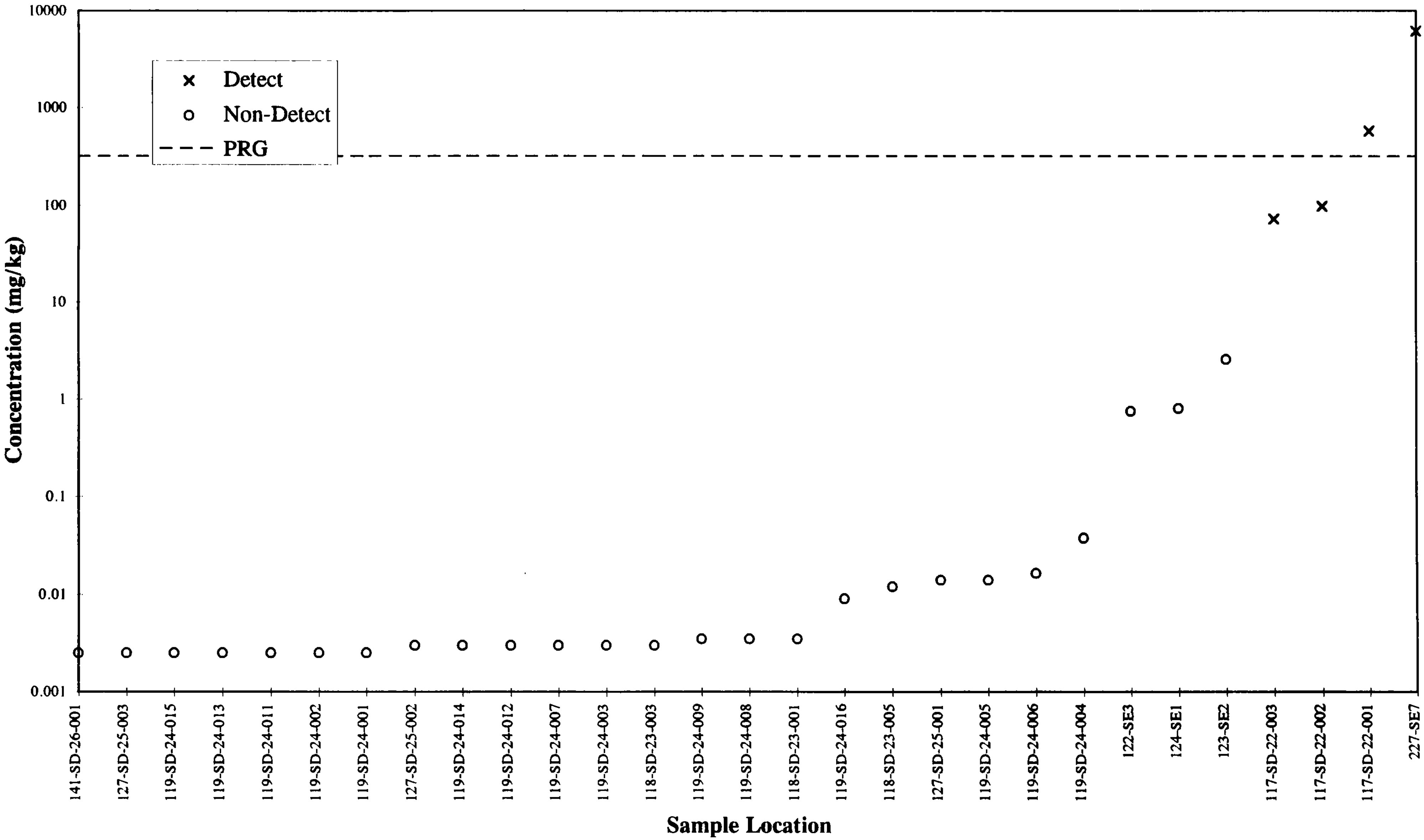

Figure 4-34
Comparison of Aroclor-1242 Perched Groundwater Data to RBC Criteria

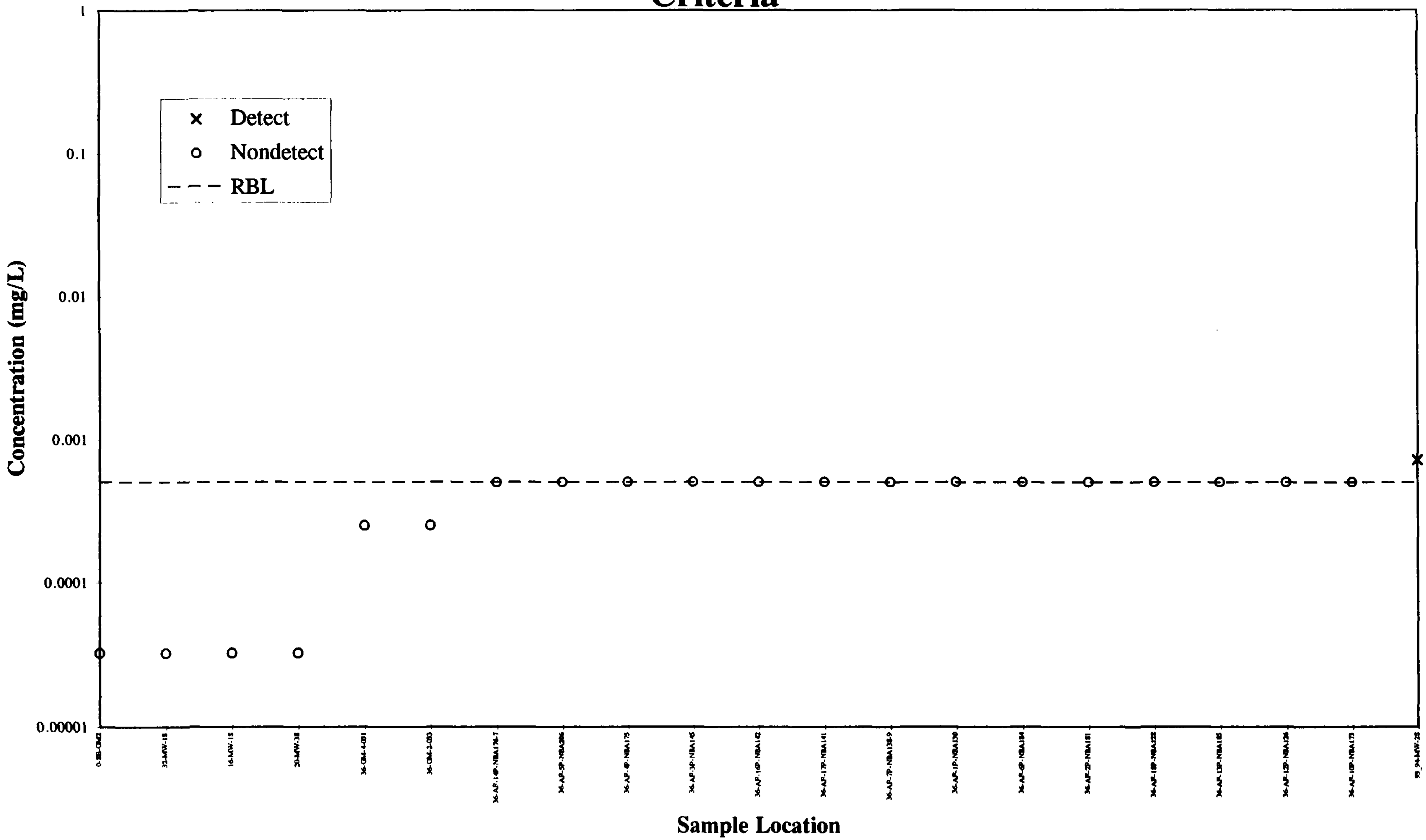

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Figure 4-35
Comparison of Aroclor-1248 Perched Groundwater Data to RBC Criteria

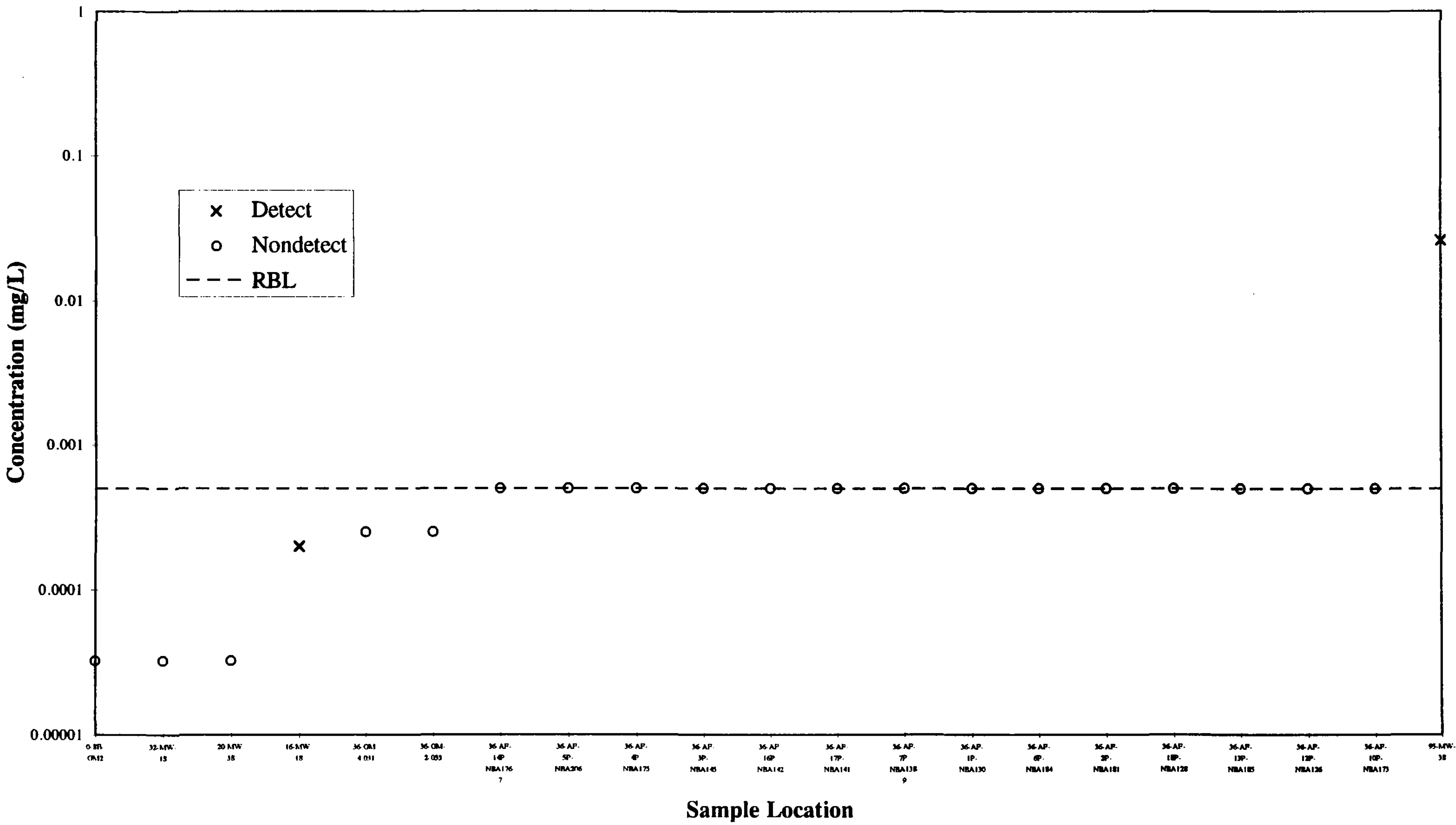

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Figure 4-36
Comparison of Arsenic Perched Groundwater Data to RBC Criteria

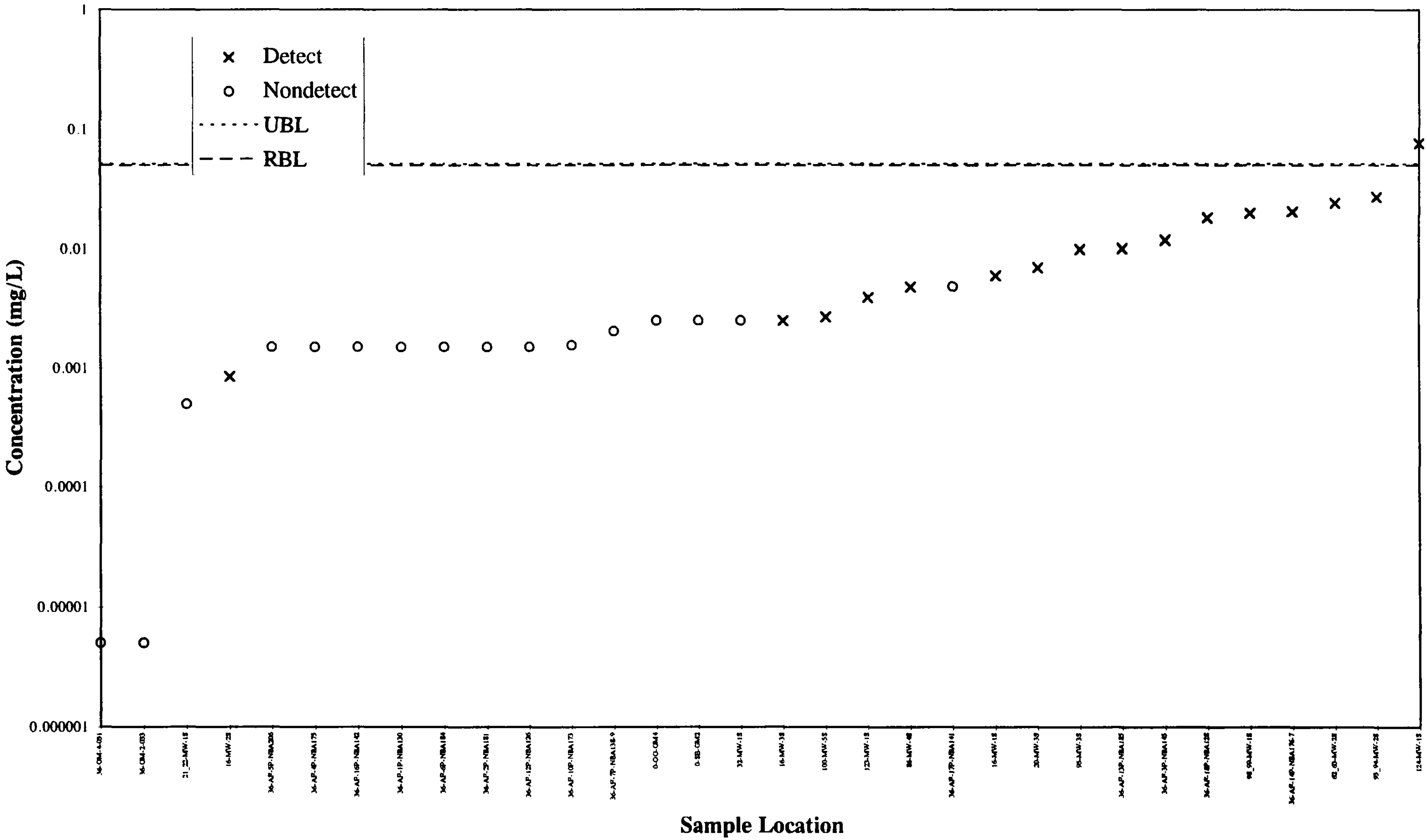

Figure 4-37
Comparison of Benzene Perched Groundwater Data to RBC Criteria

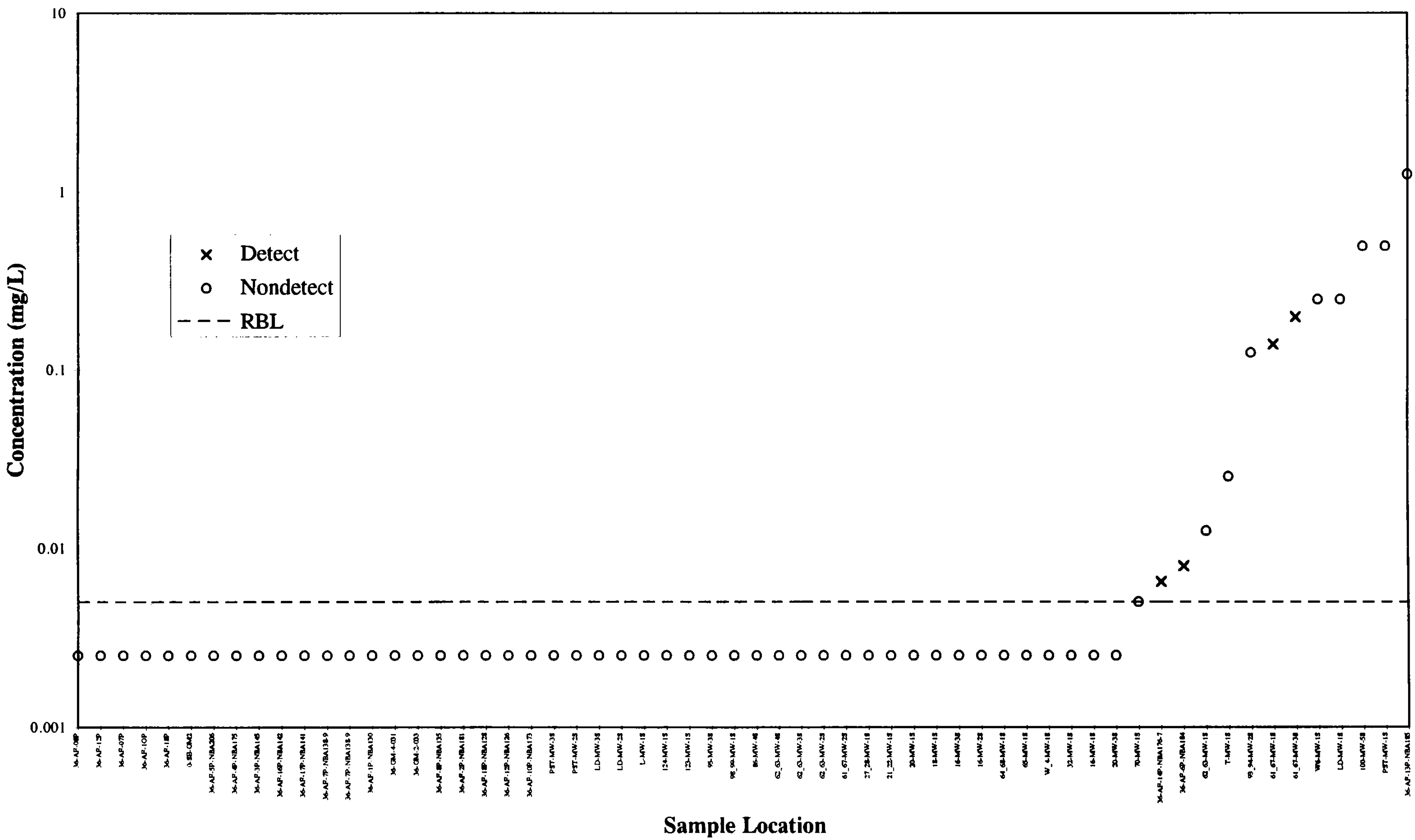

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Figure 4-38
Comparison of Bis(2-Ethylhexyl)Phthalate Perched Groundwater Data to RBC Criteria

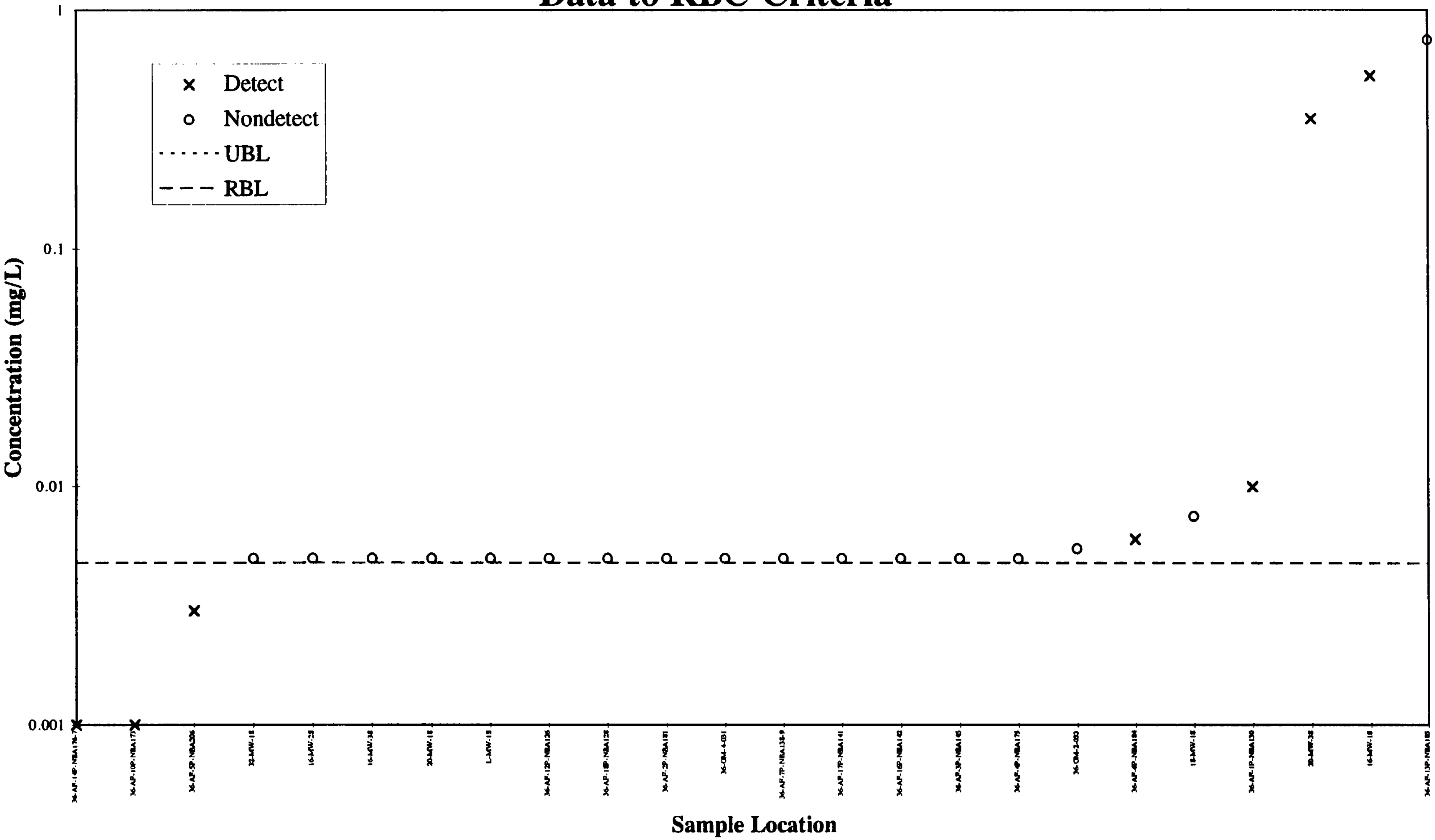

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Figure 4-39
Comparison of Cadmium Perched Groundwater Data to RBC Criteria

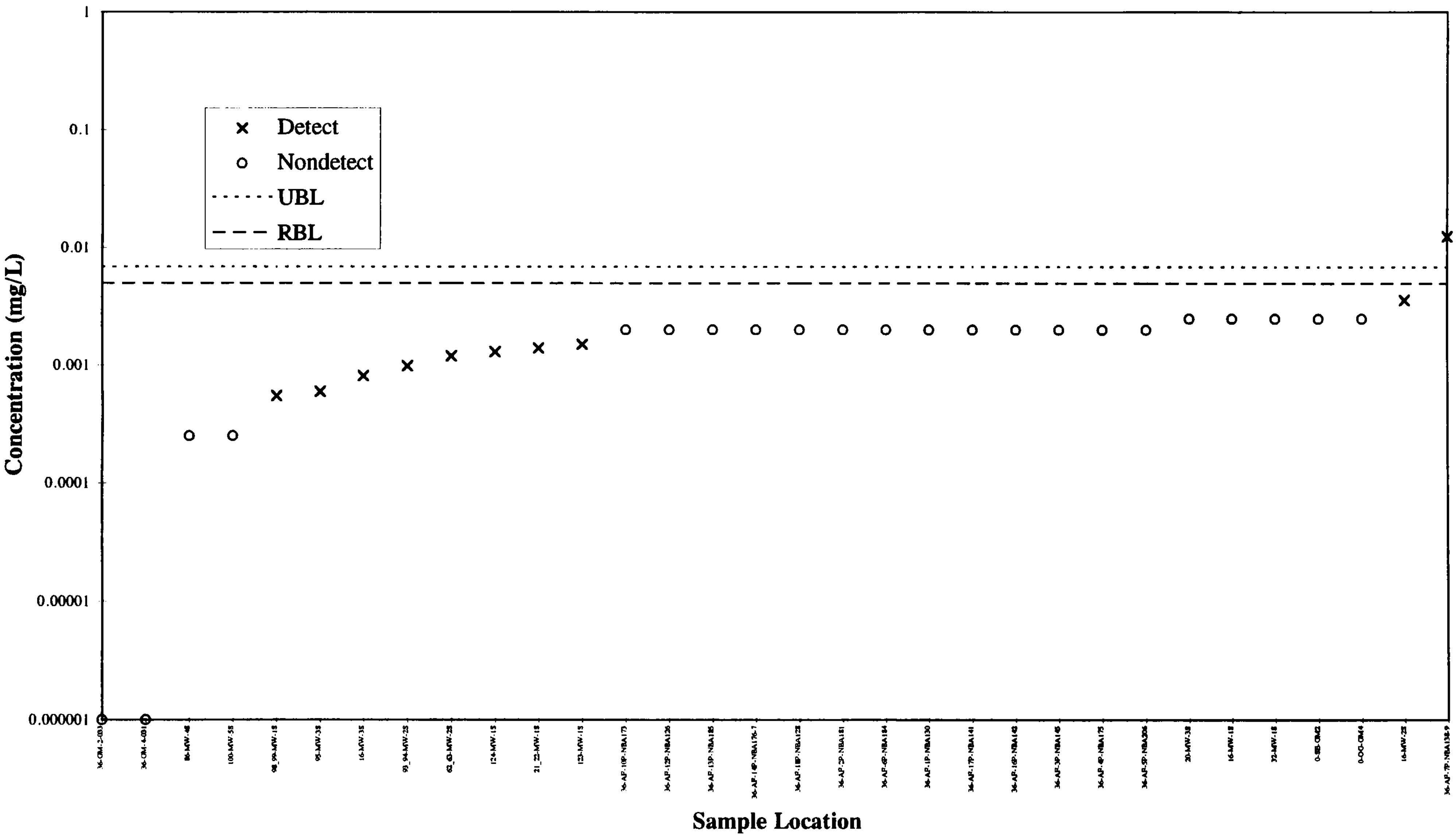

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Figure 4-40
Comparison of Chromium Perched Groundwater Data to RBC Criteria

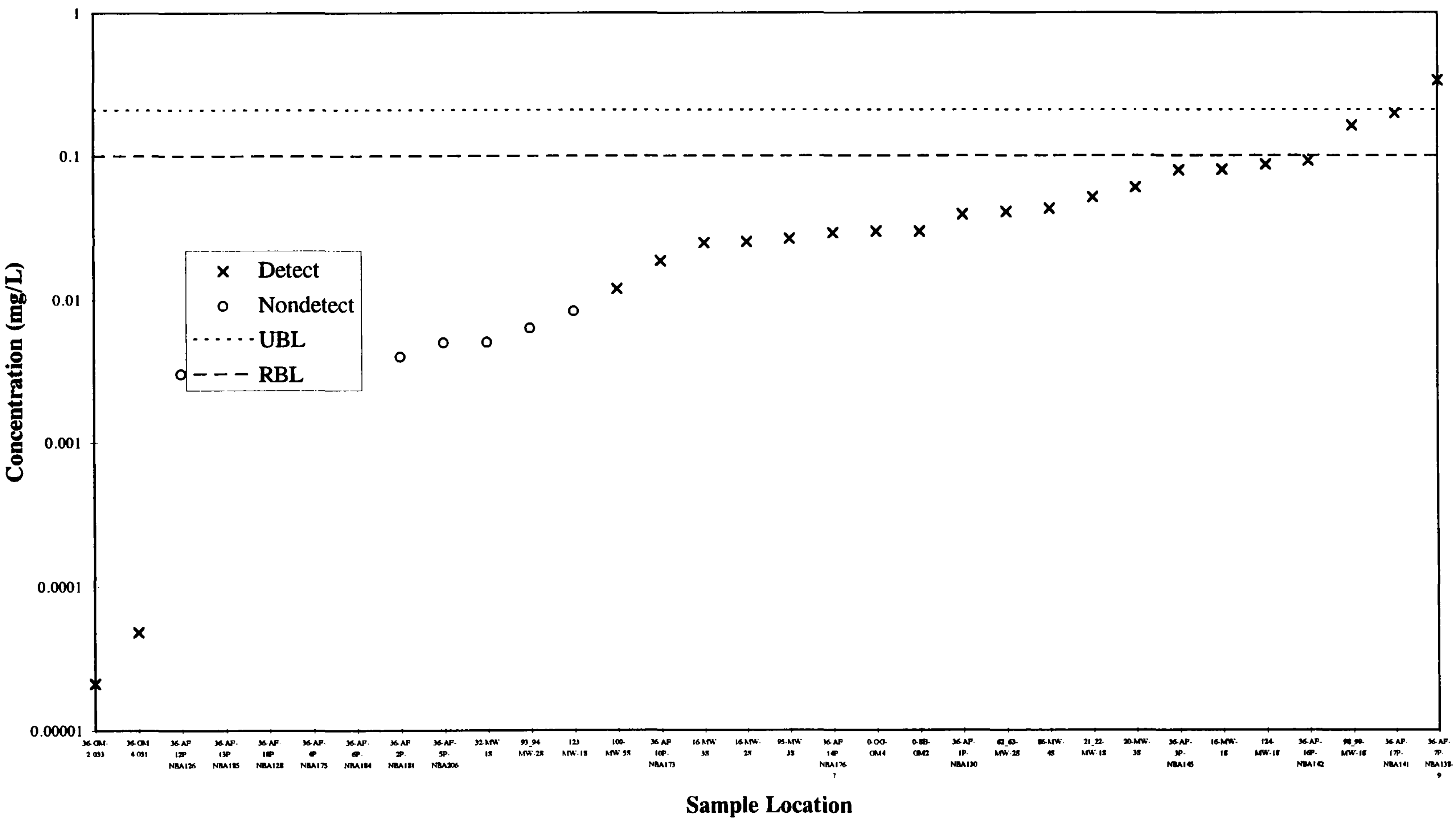

Figure 4-41
Comparison of Dibenzofuran Perched Groundwater Data to RBC Criteria

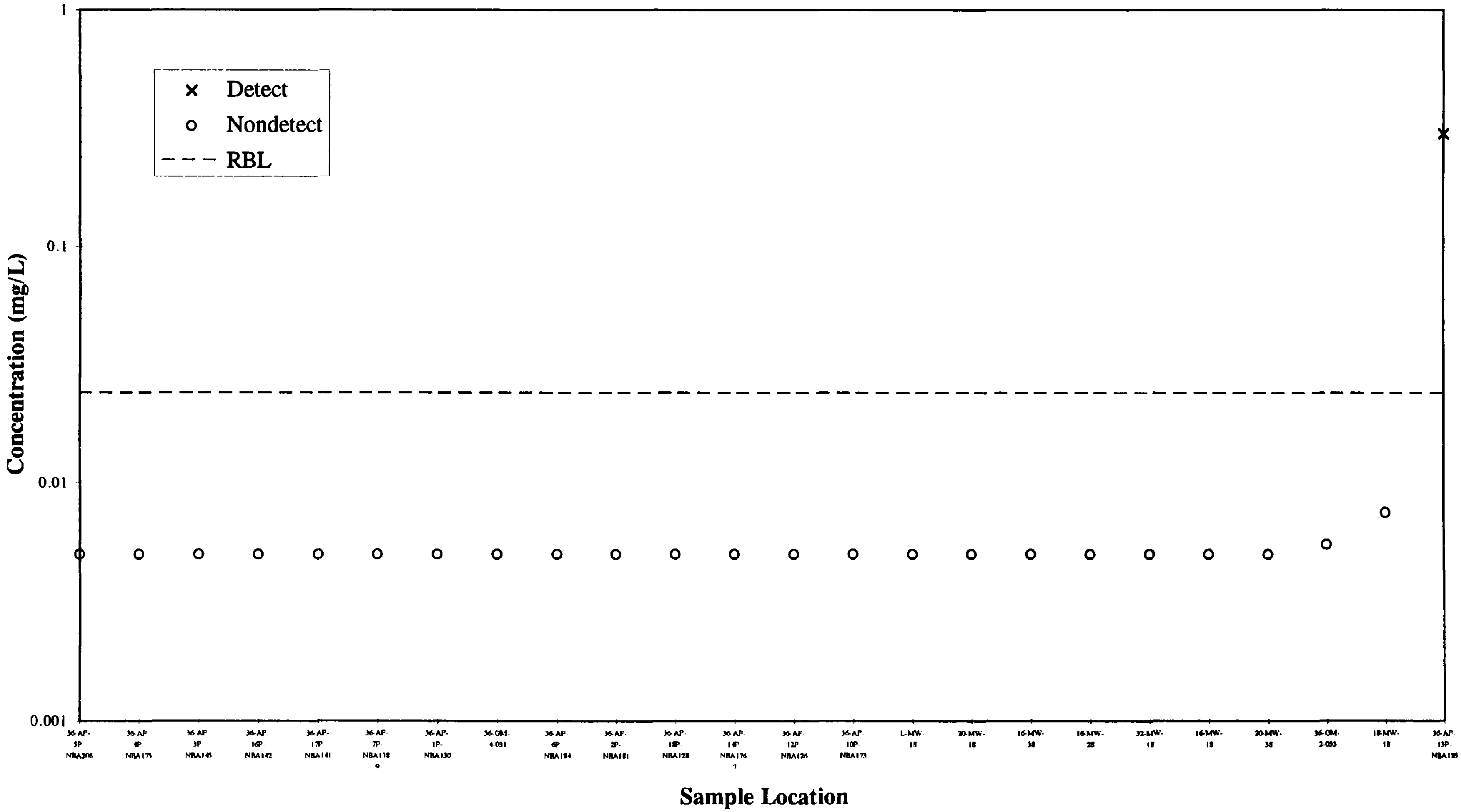

Figure 4-42
Comparison of 1,2-Dichloroethane Perched Groundwater Data to RBC Criteria

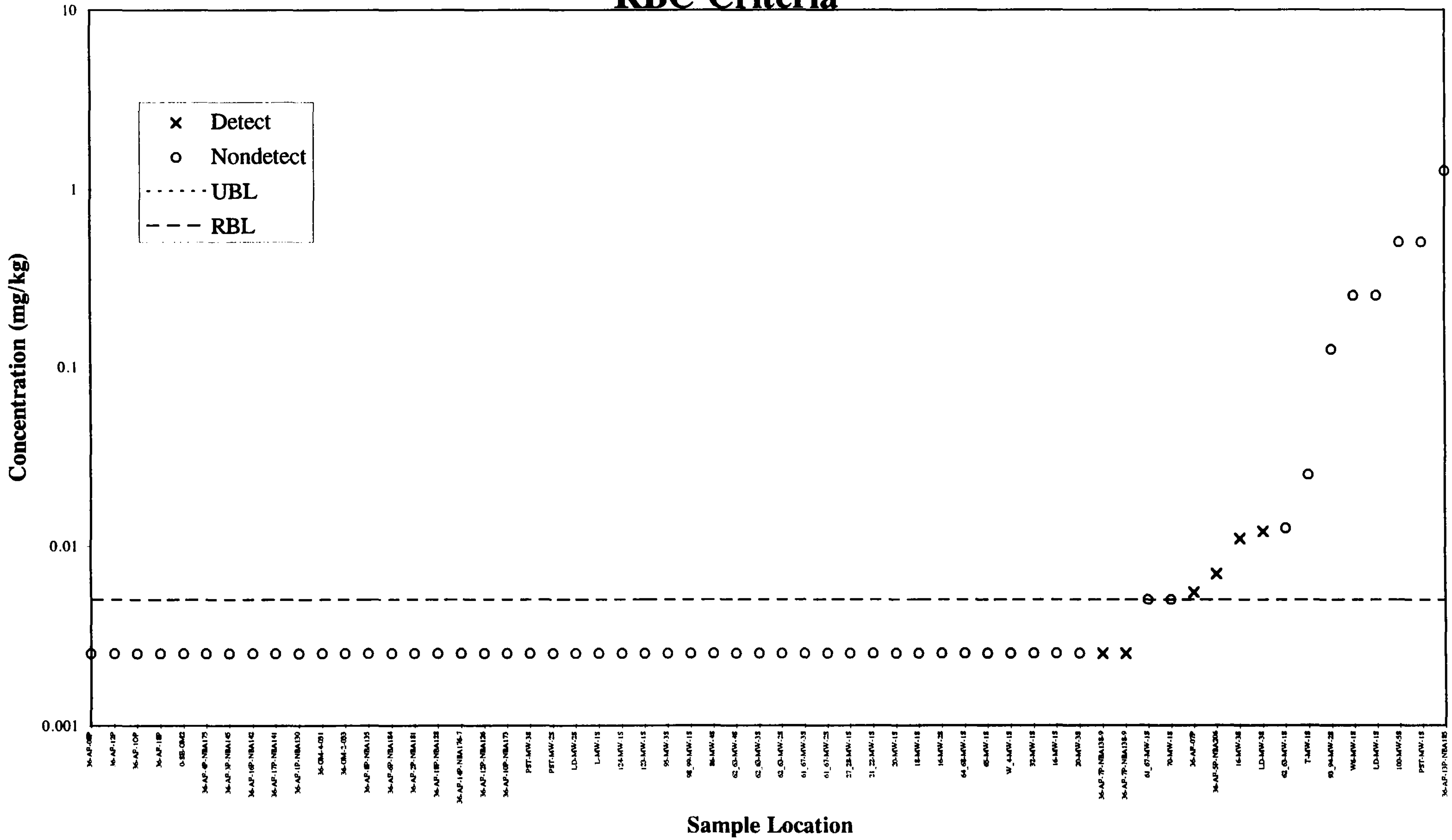

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Figure 4-43
Comparison of 1,1-Dichloroethene Perched Groundwater Data to RBC Criteria

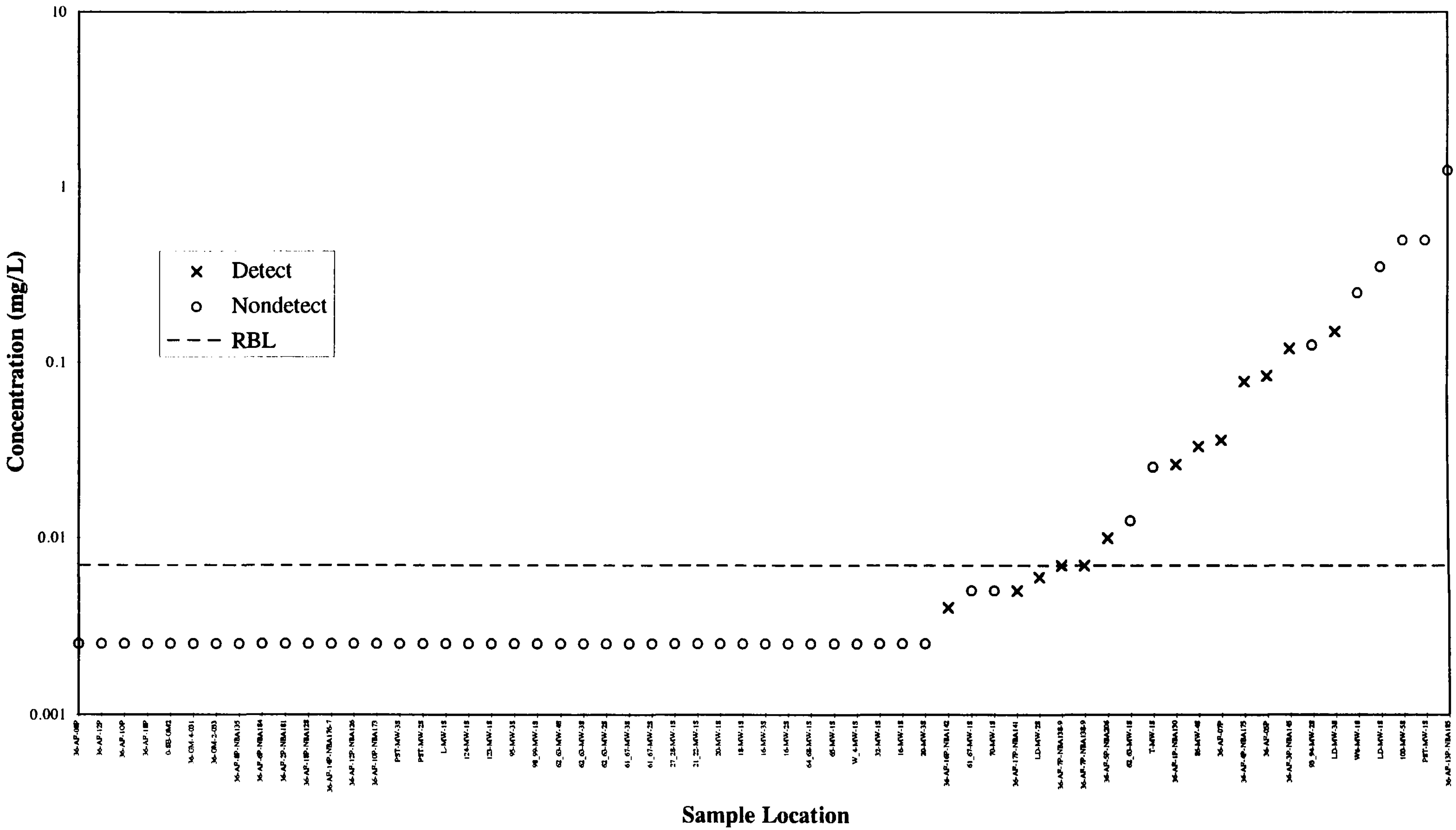

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Figure 4-44

Comparison of 1,2-Dichloroethene Perched Groundwater Data to RBC Criteria

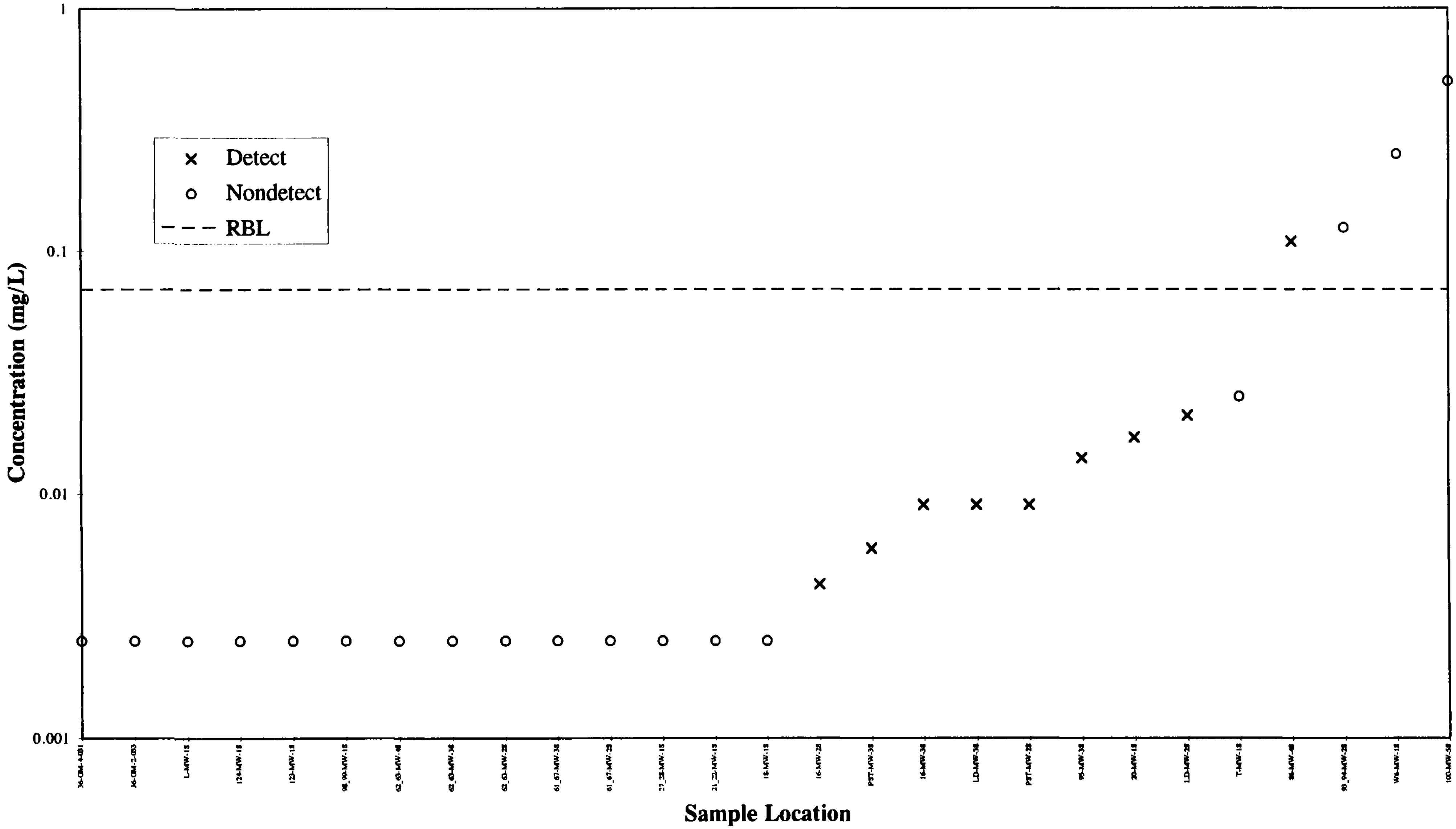

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Figure 4-45
Comparison of Cis-1,2-Dichloroethene Perched Groundwater Data to RBC Criteria

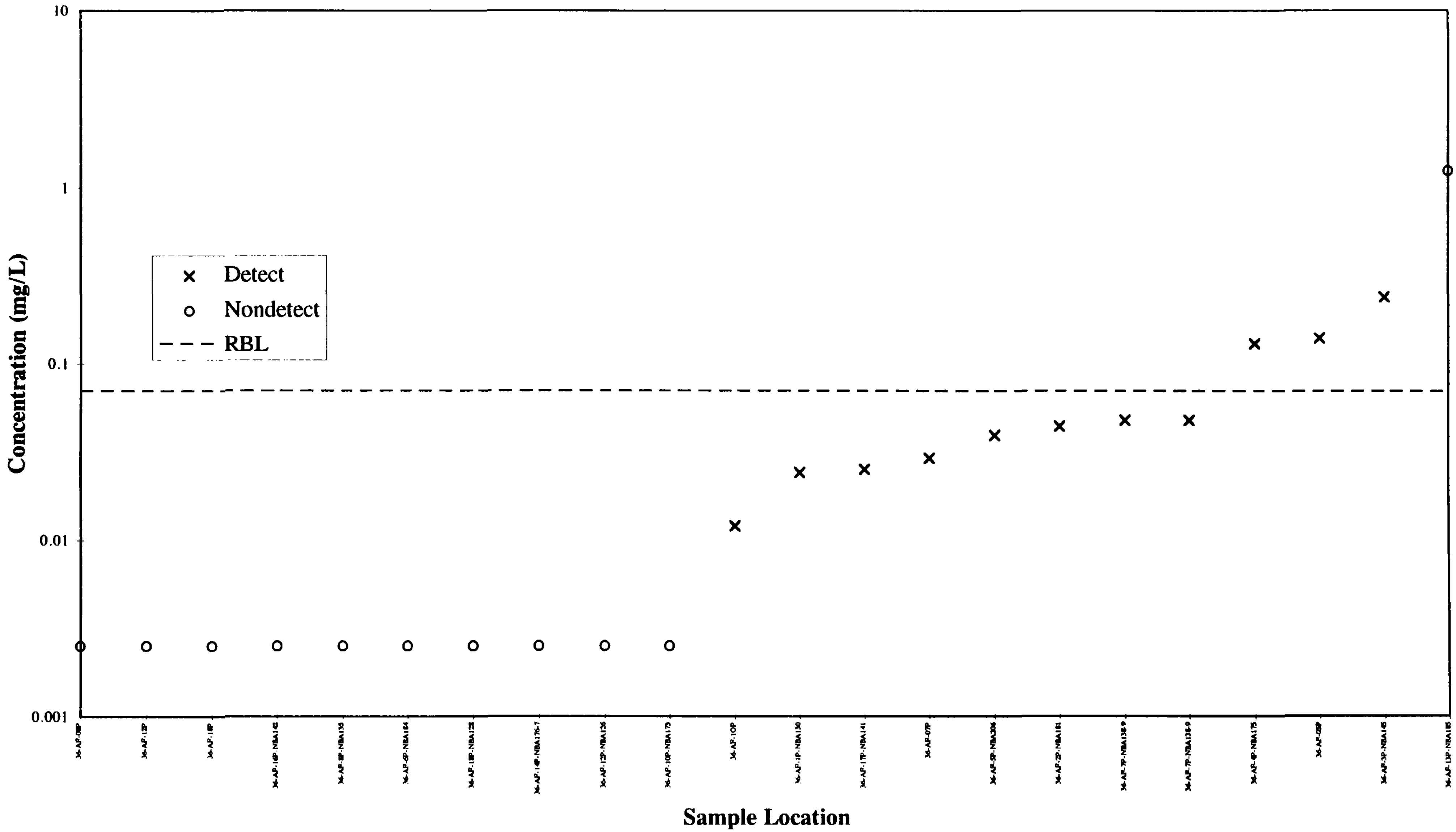

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Figure 4-46
Comparison of Fluorene Perched Groundwater Data to RBC Criteria

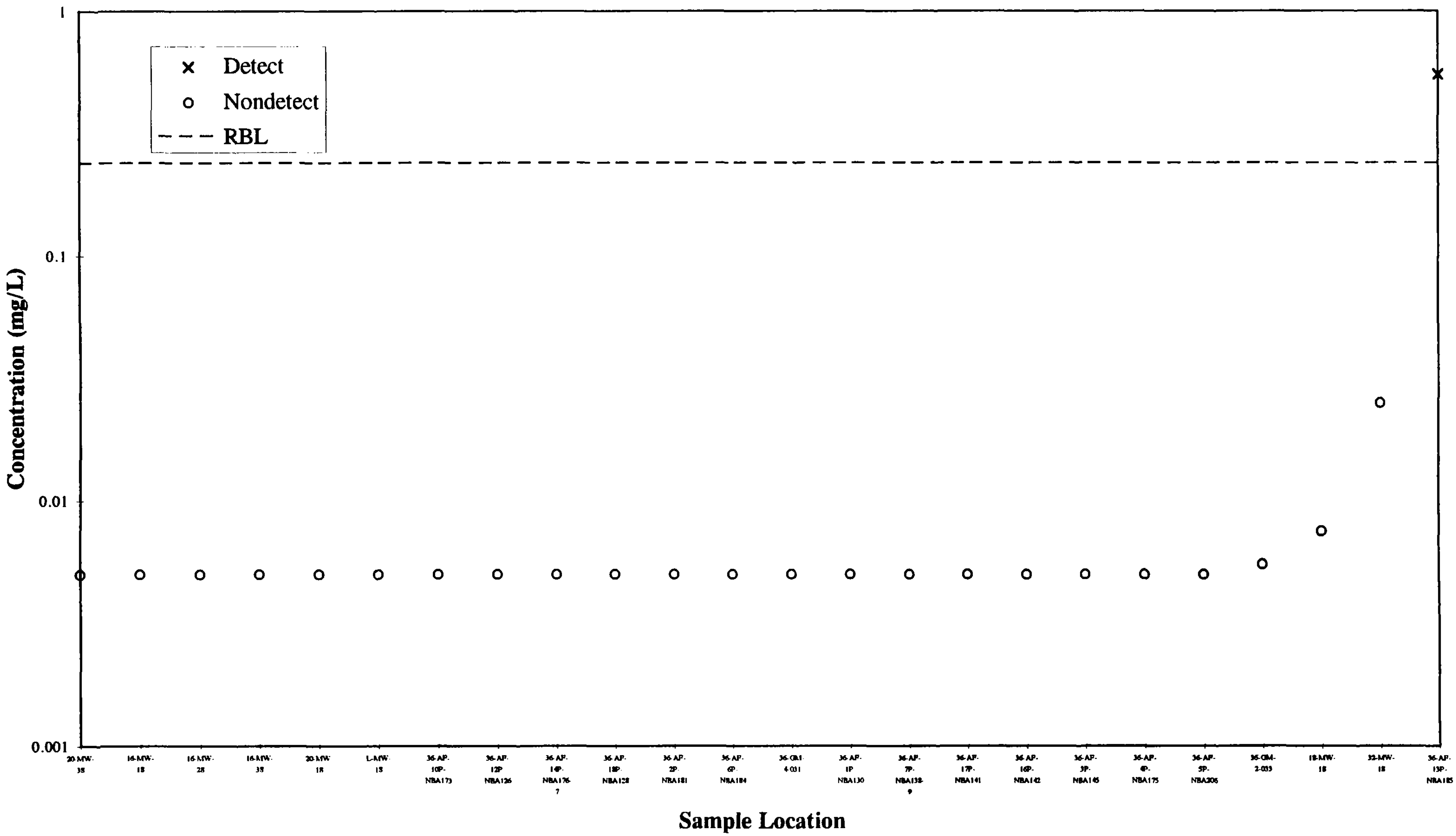

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Figure 4-47
Comparison of Methylene Chloride Perched Groundwater Data to RBC Criteria

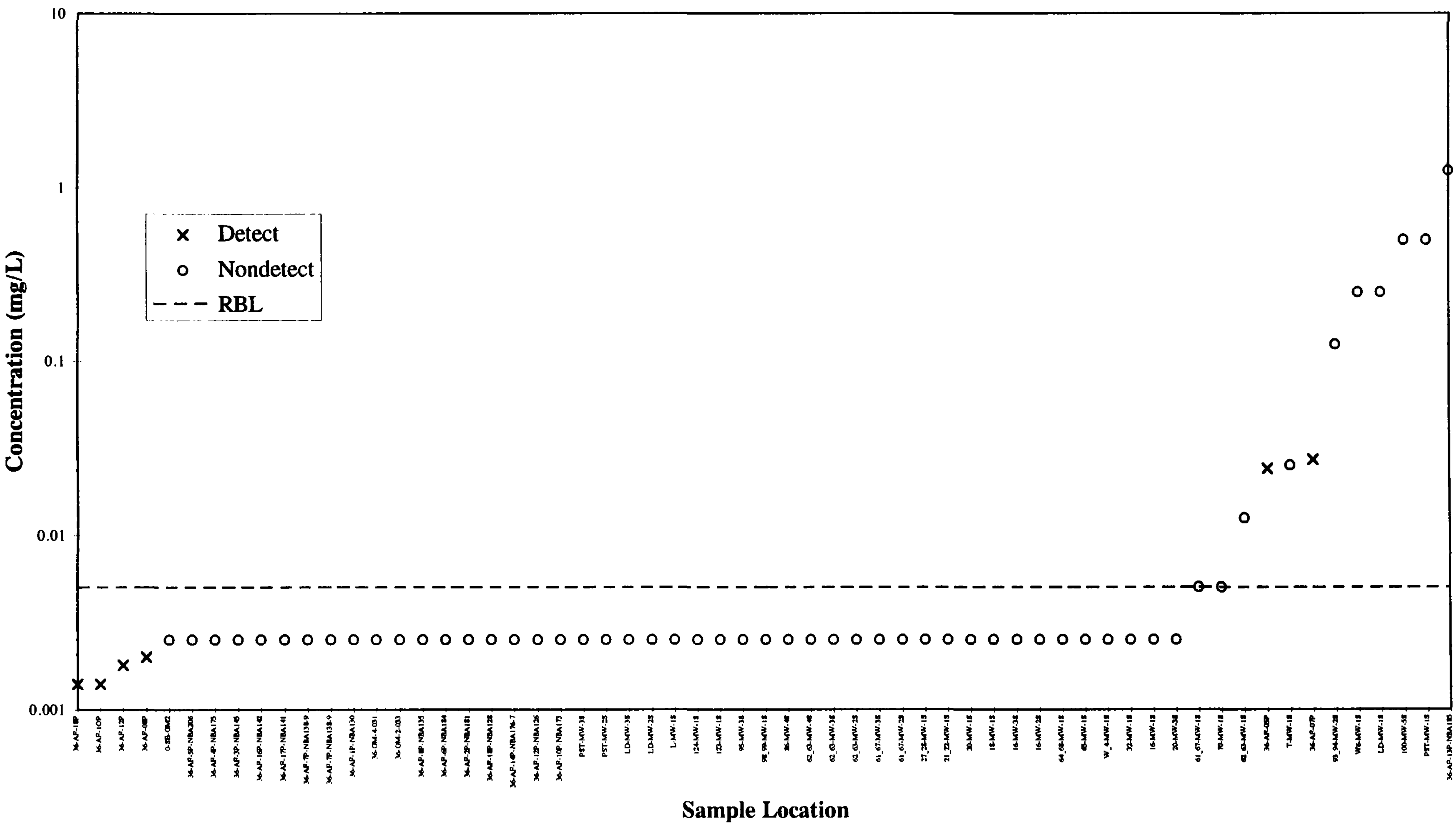

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Figure 4-48
Comparison of 2-Methylnaphthalene Perched Groundwater Data to RBC Criteria

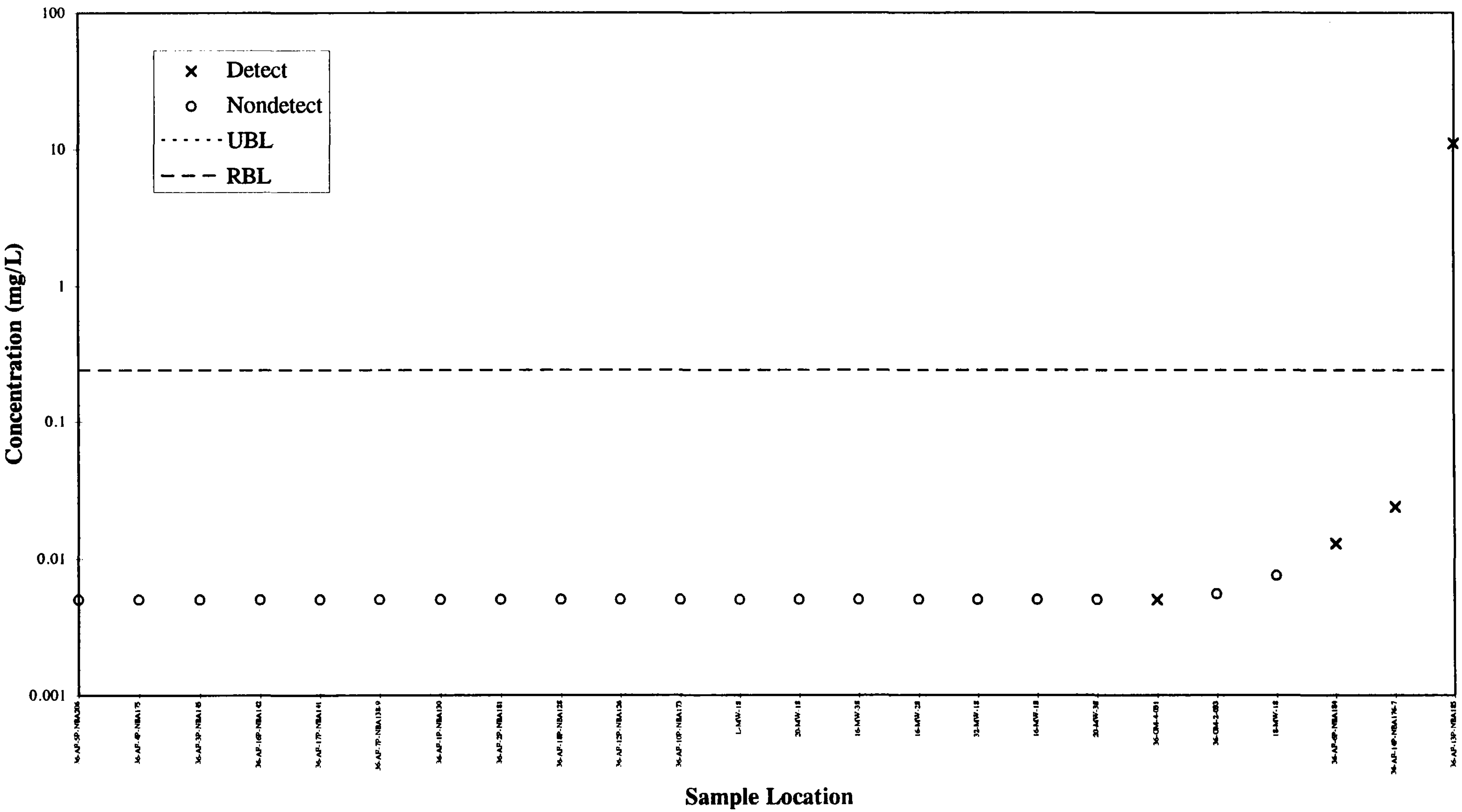

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Figure 4-49
Comparison of Naphthalene Perched Groundwater Data to RBC Criteria

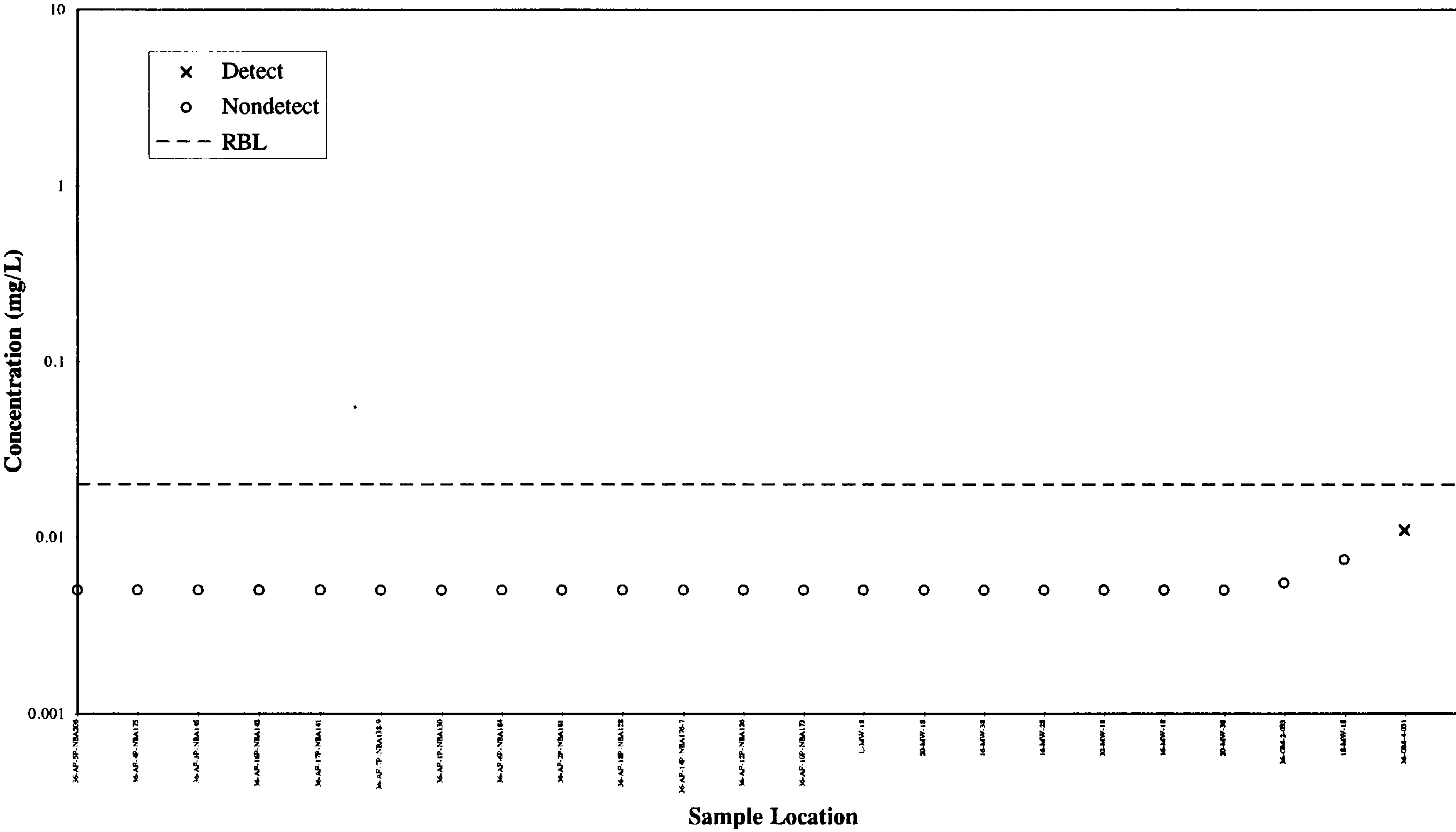

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Figure 4-50
Comparison of Nickel Perched Groundwater Data to RBC Criteria

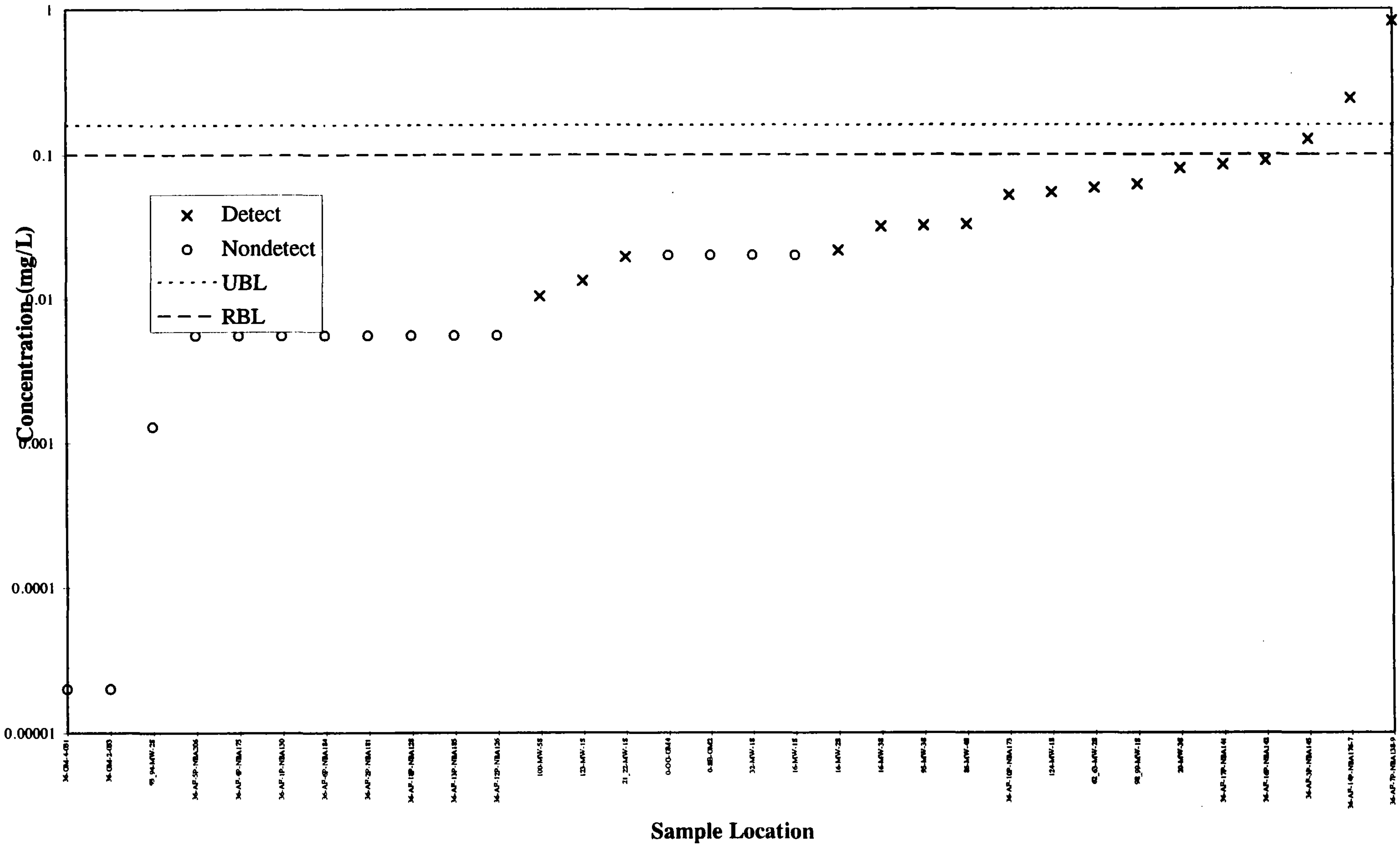

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Figure 4-51
Comparison of N-Nitrosodiphenylamine Perched Groundwater Data to RBC Criteria

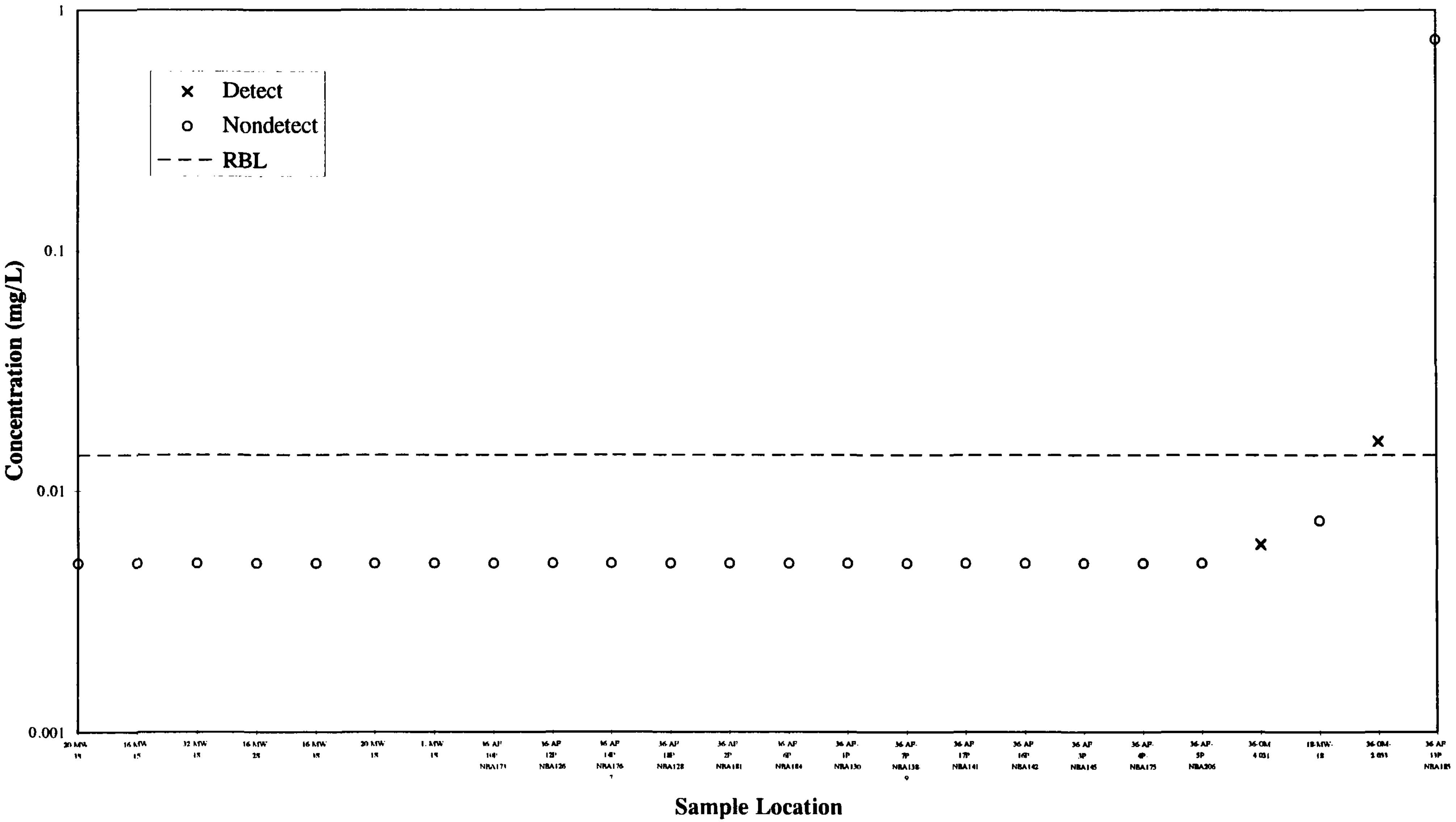

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Figure 4-52
Comparison of Phenanthrene Perched Groundwater Data to RBC Criteria

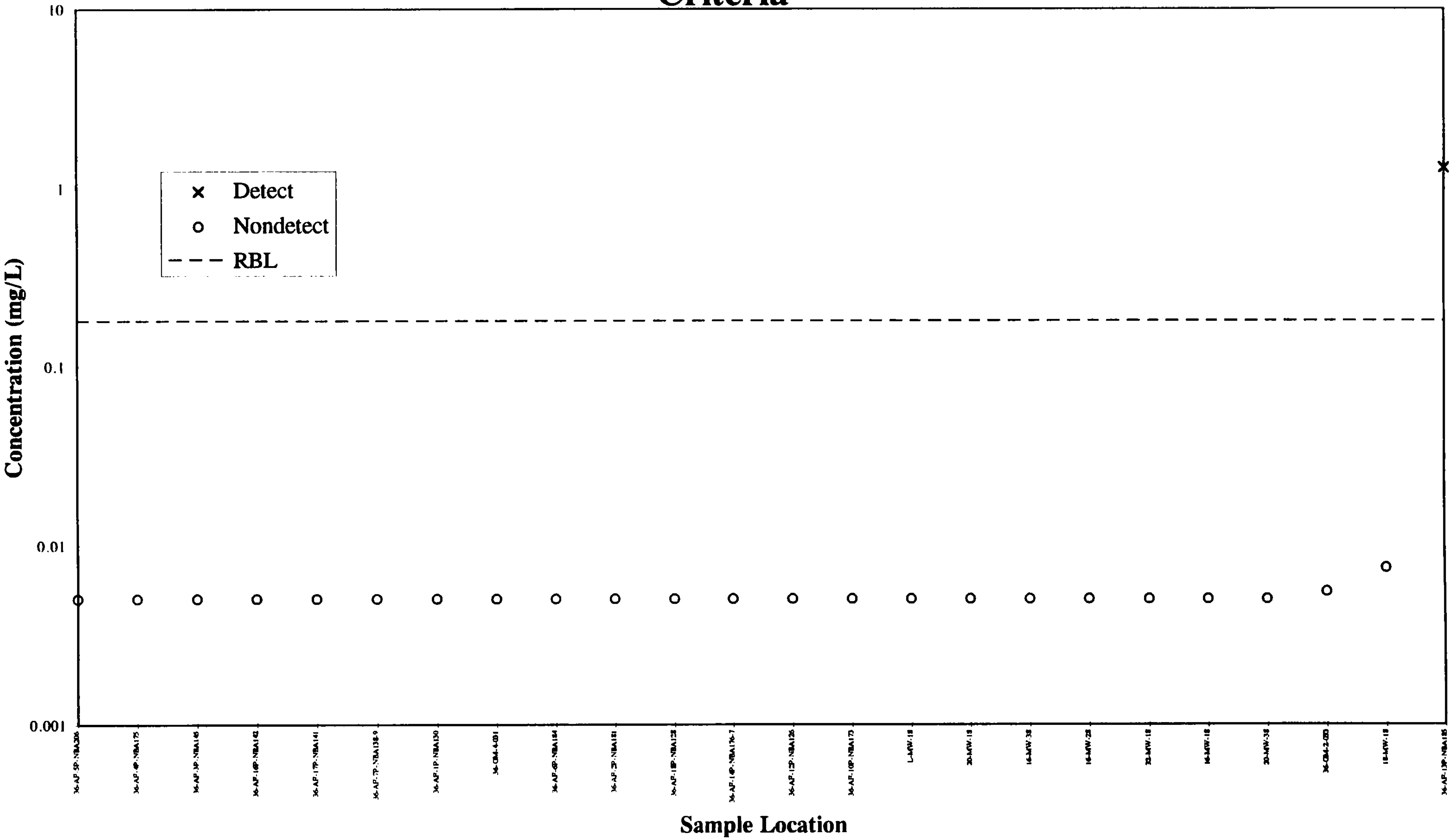

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Figure 4-53
Comparison of Tetrachloroethene Perched Groundwater Data to RBC Criteria

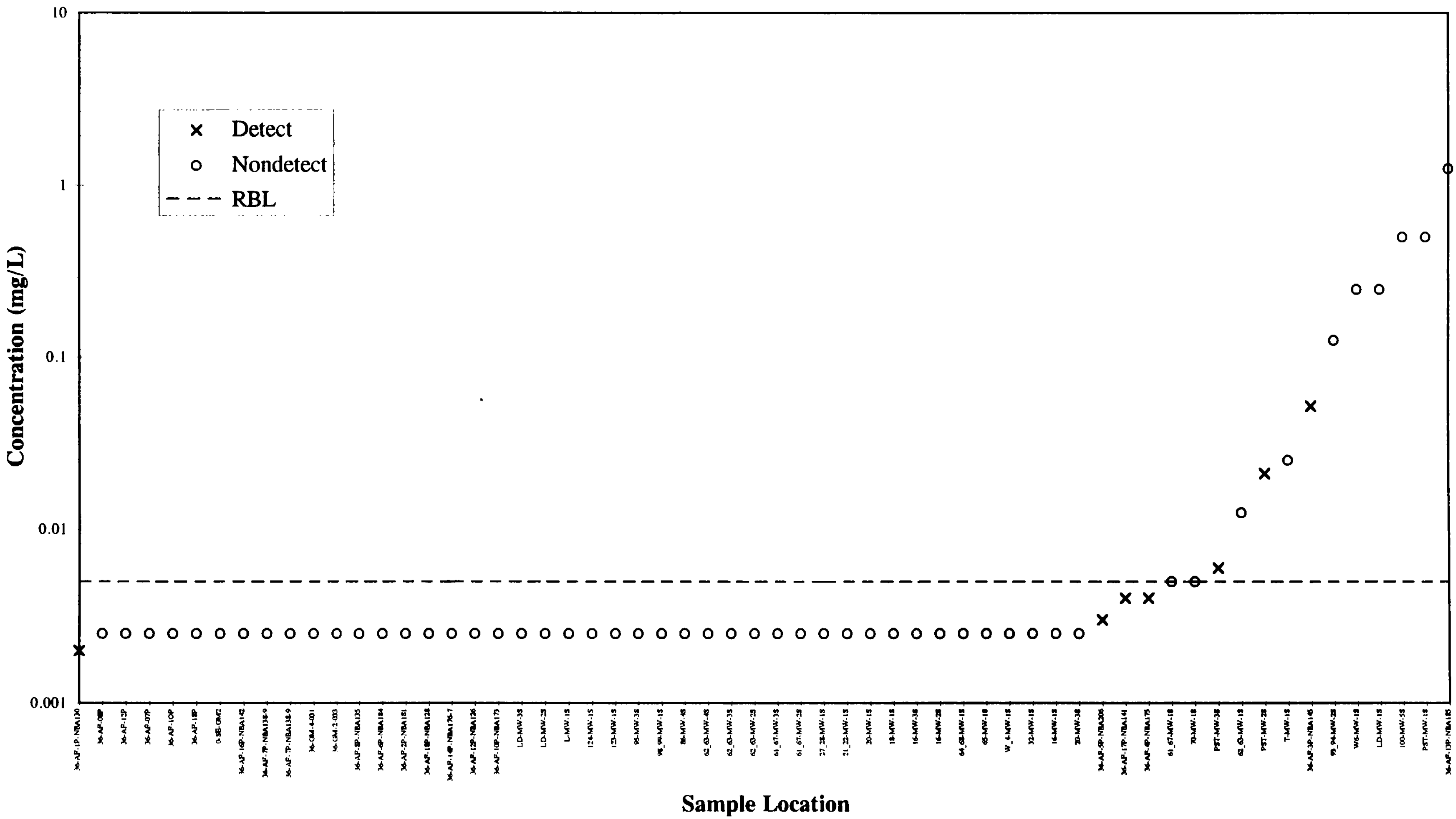

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Figure 4-54
Total Petroleum Hydrocarbon Perched Groundwater RBC Data

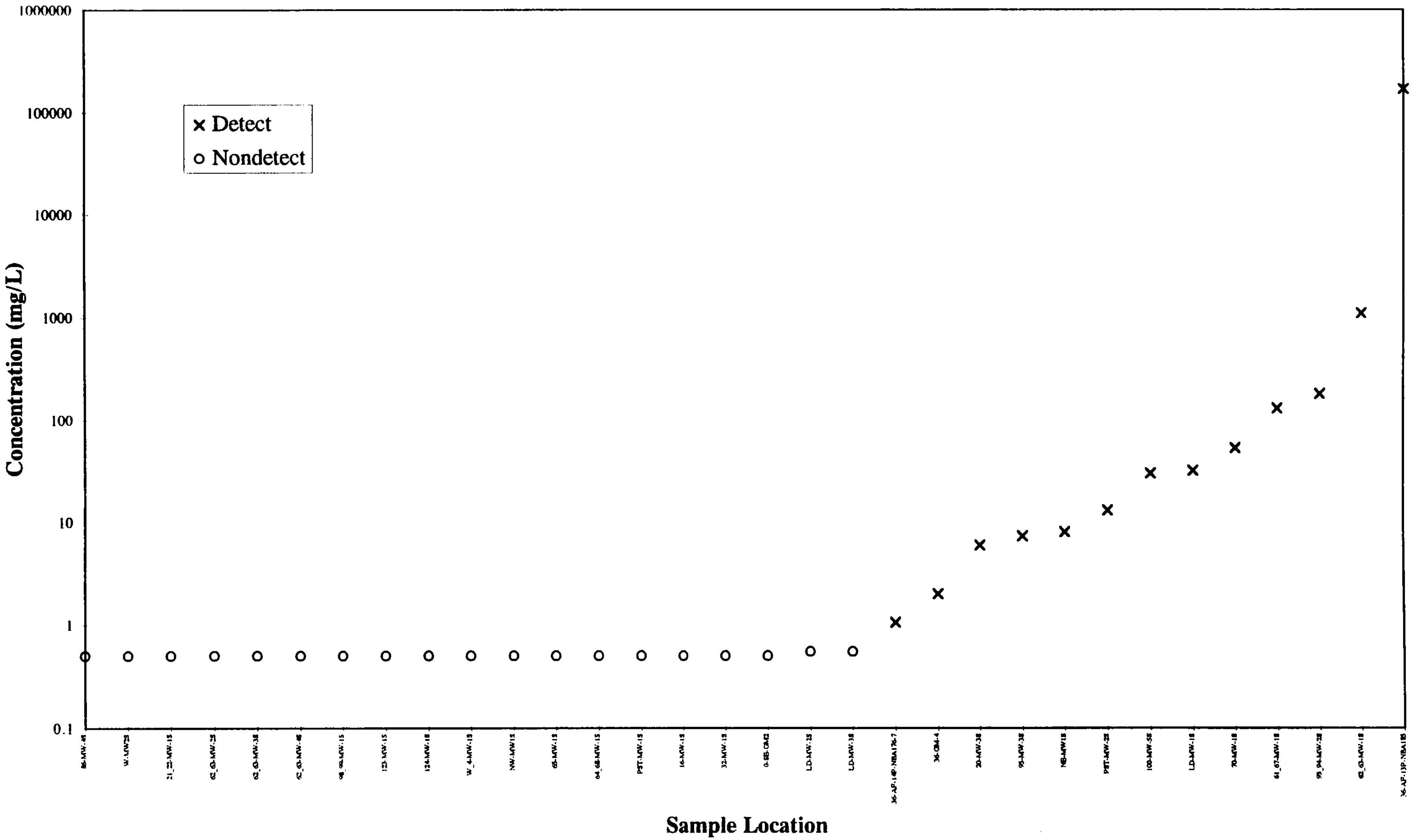

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Figure 4-55
Comparison of 1,1,2-Trichloroethane Perched Groundwater Data to RBC Criteria

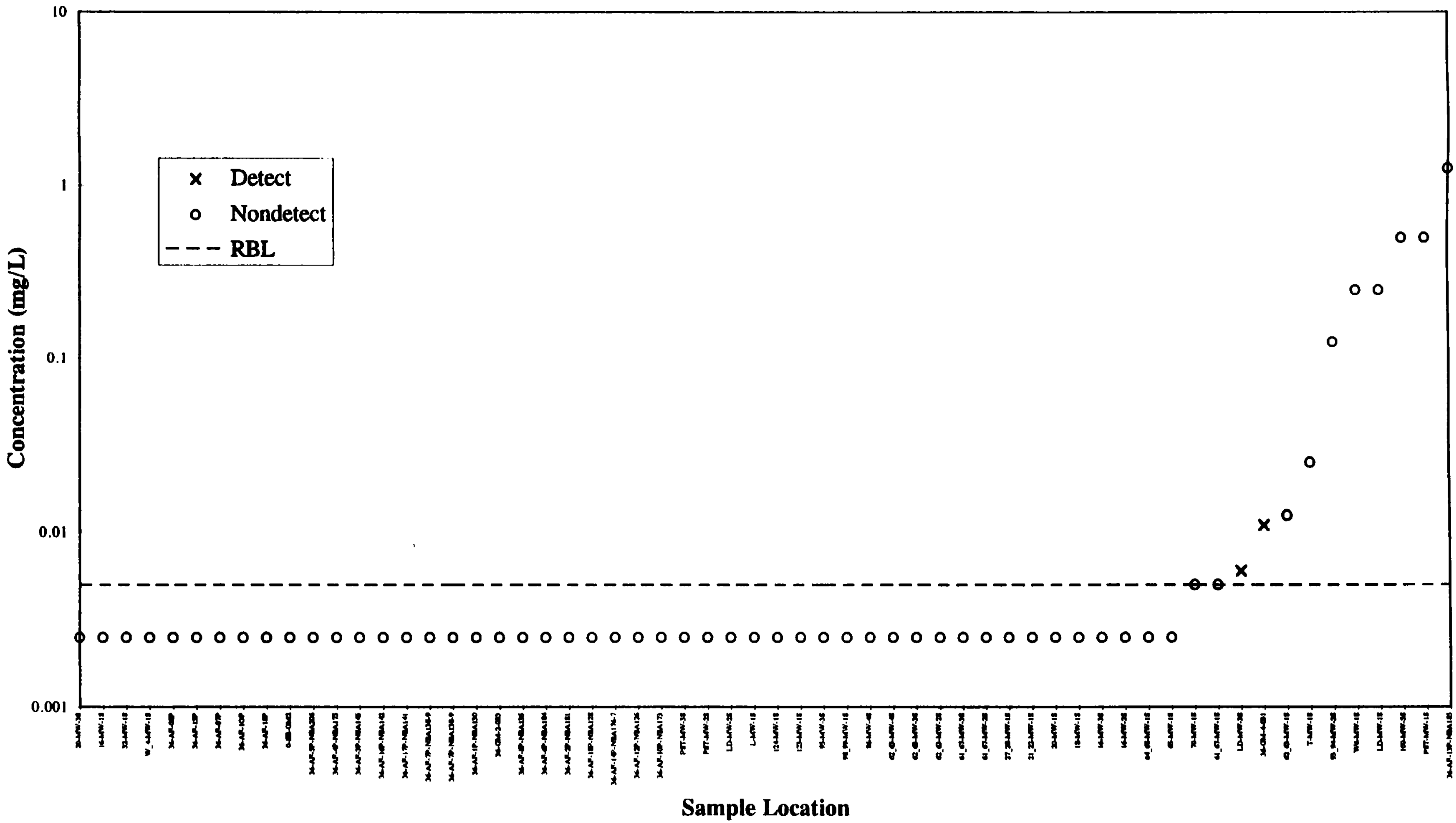

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Figure 4-56
Comparison of Trichloroethene Perched Groundwater Data to RBC Criteria

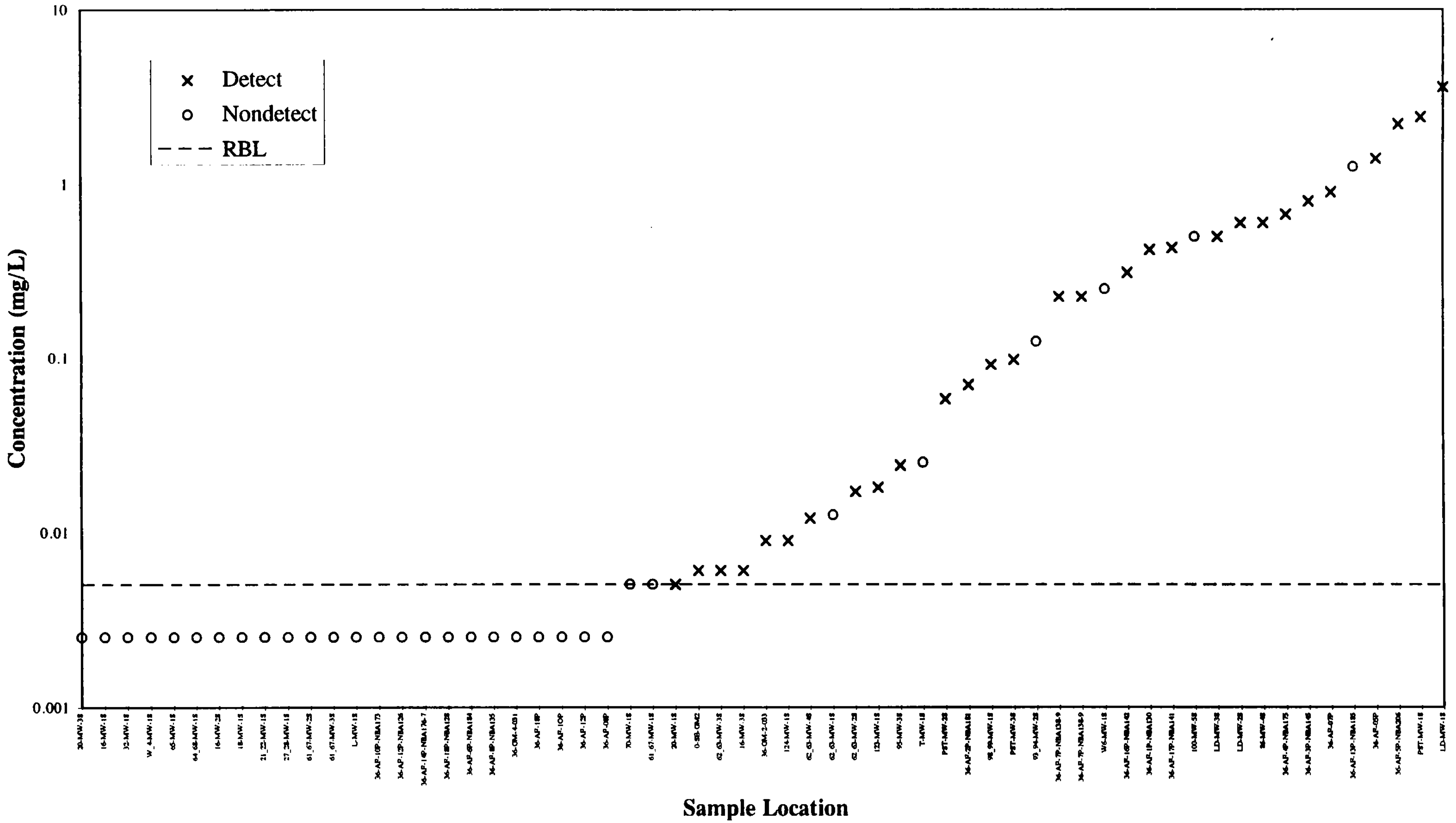

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Figure 4-57
Comparison of Vinyl Acetate Perched Groundwater Data to RBC Criteria

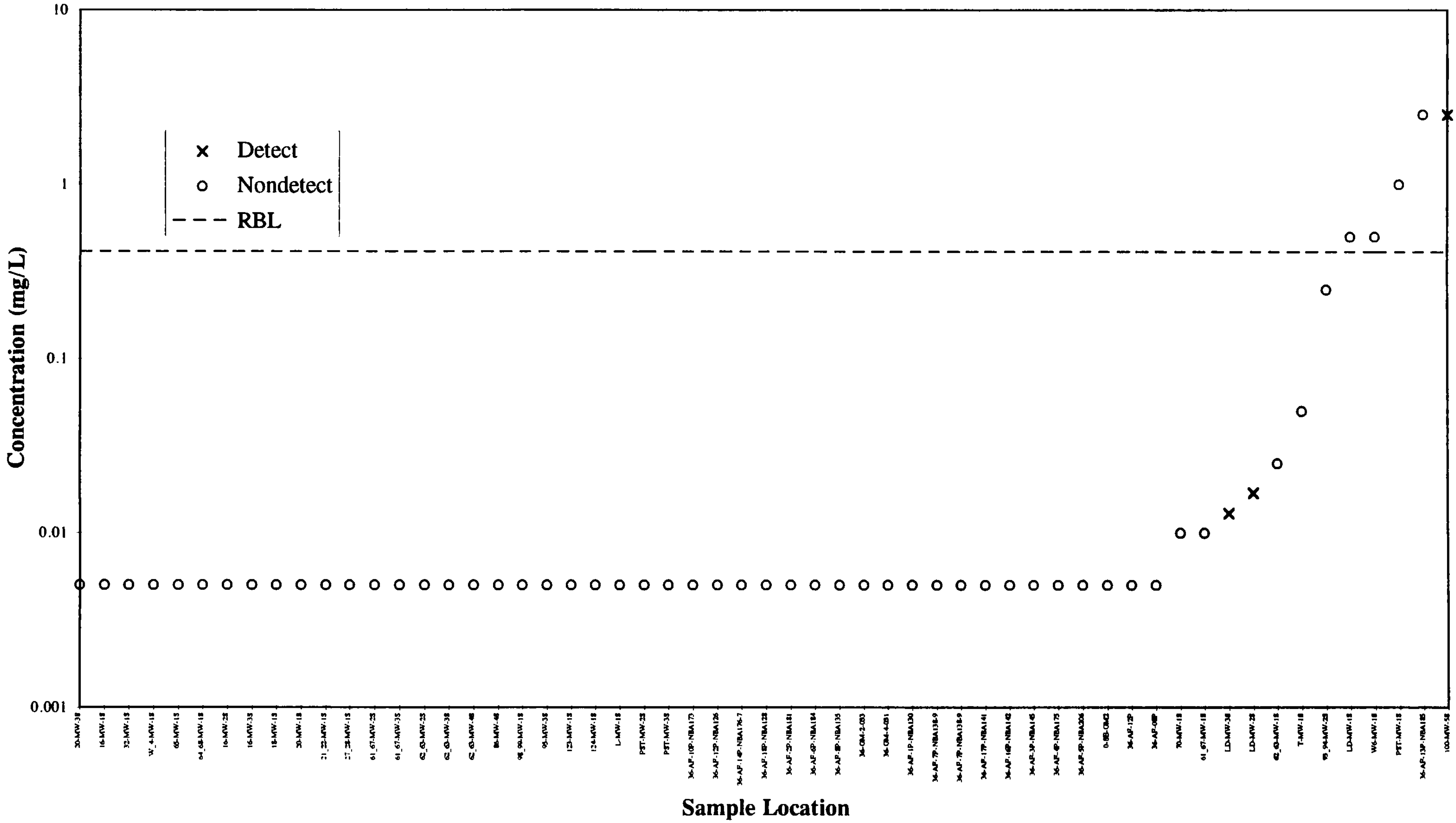

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Figure 4-58
Comparison of Vinyl Chloride Perched Groundwater Data to RBC Criteria

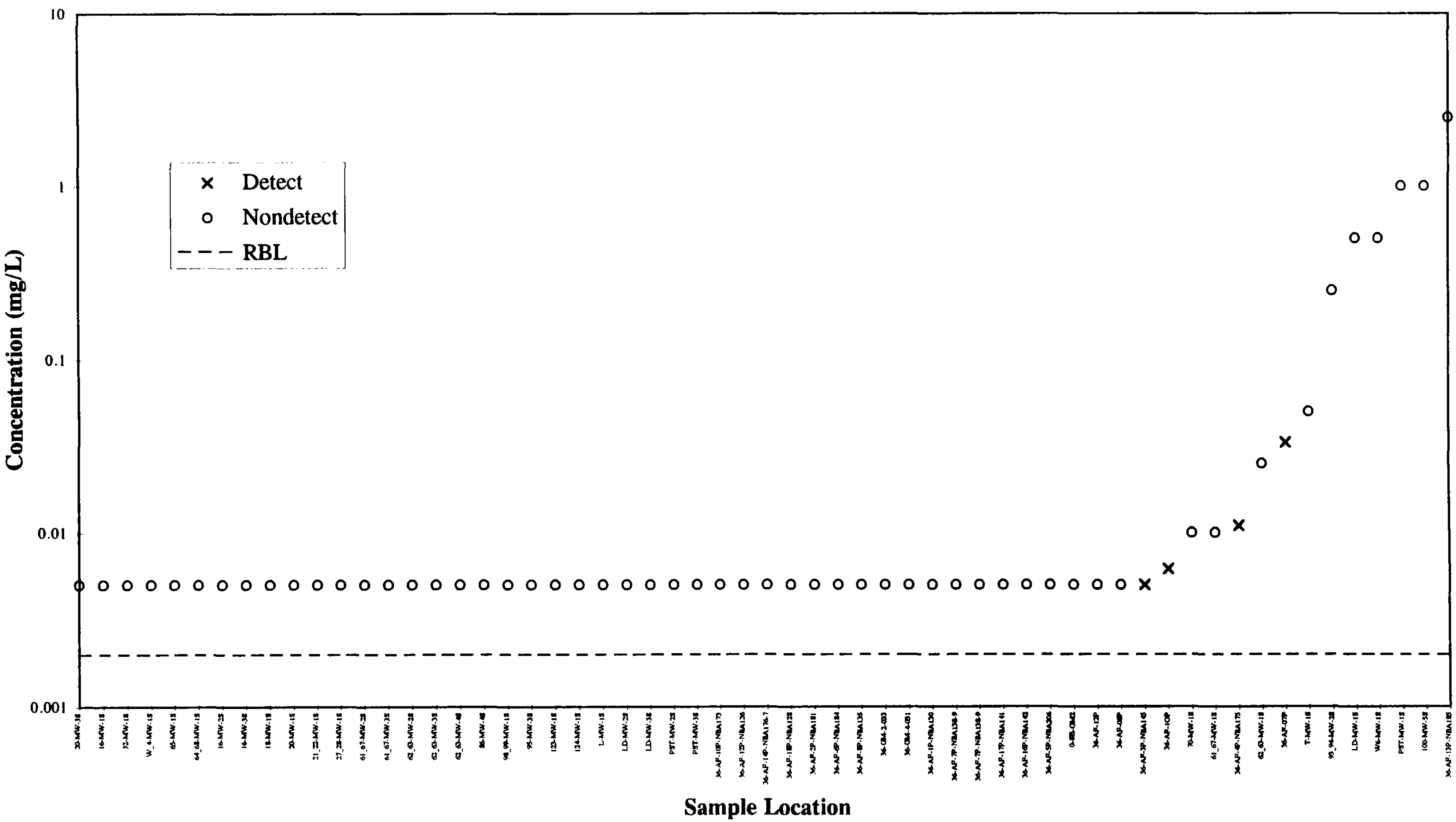

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Figure 4-59
Comparison of Benzene USG Groundwater Data to RBC Criteria

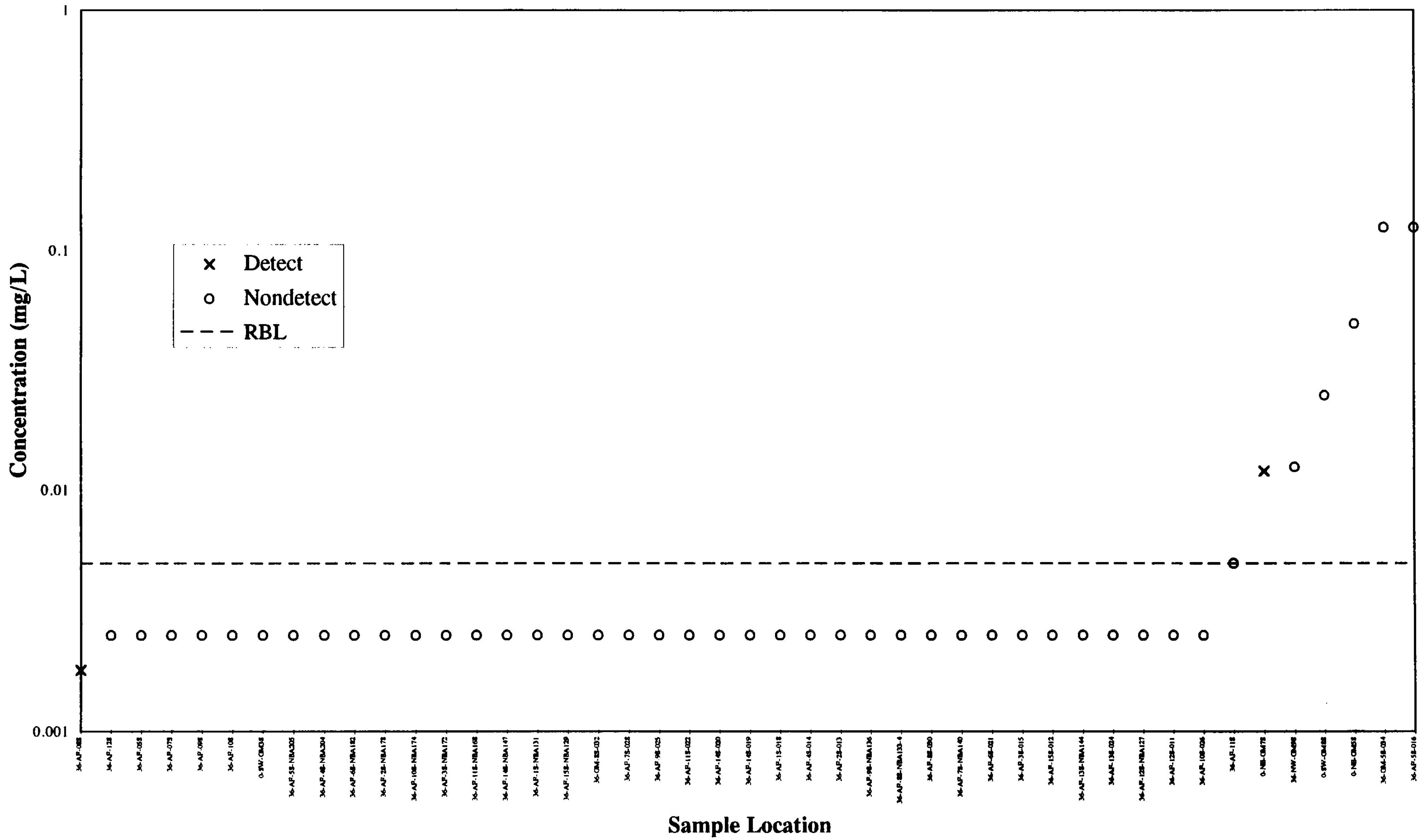

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Figure 4-60
Comparison of Bis(2-Ethylhexyl)Phthalate USG Groundwater Data to RBC Criteria

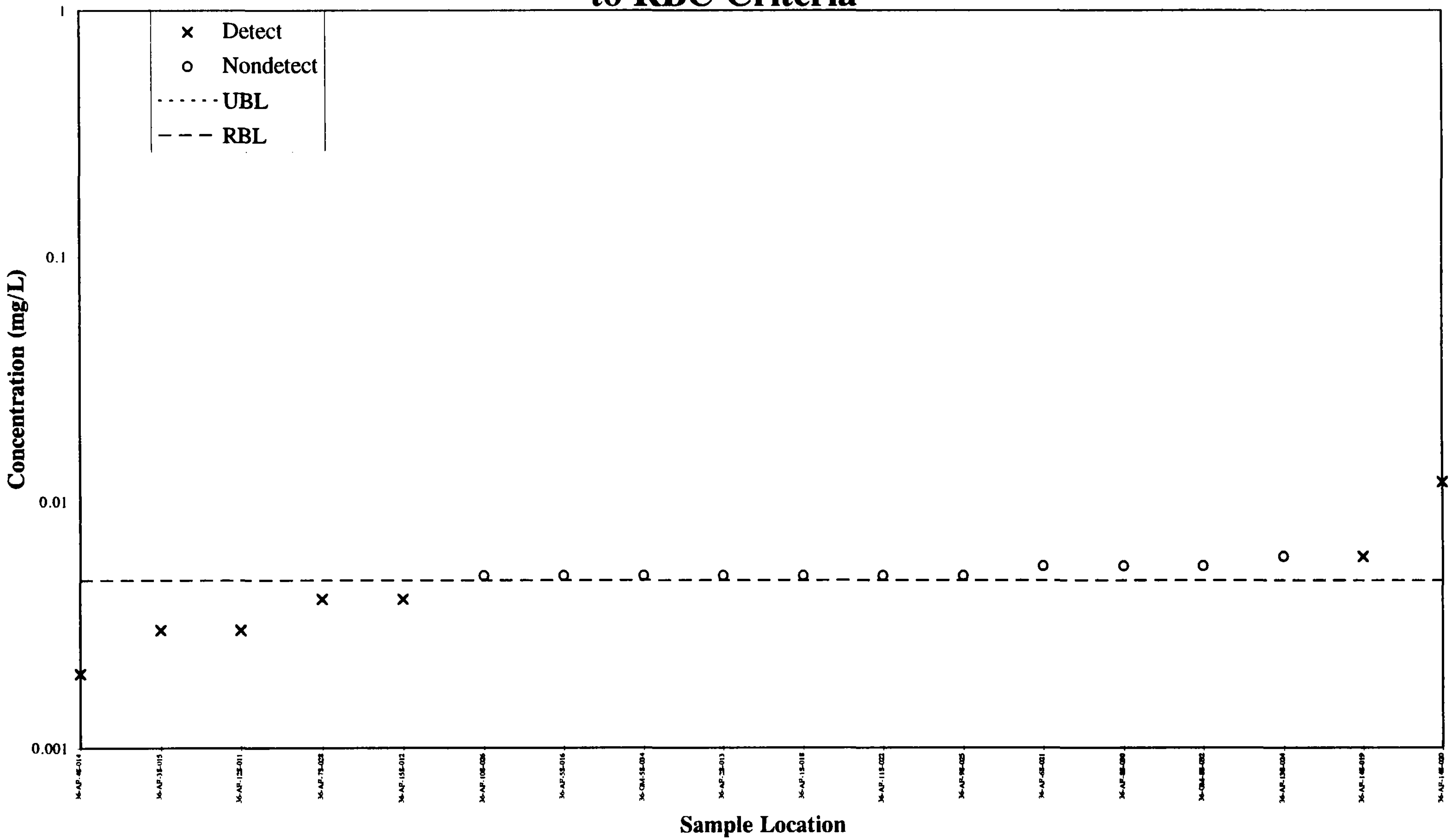

Figure 4-61
Comparison of Carbon Disulfide Groundwater Data to RBC Criteria

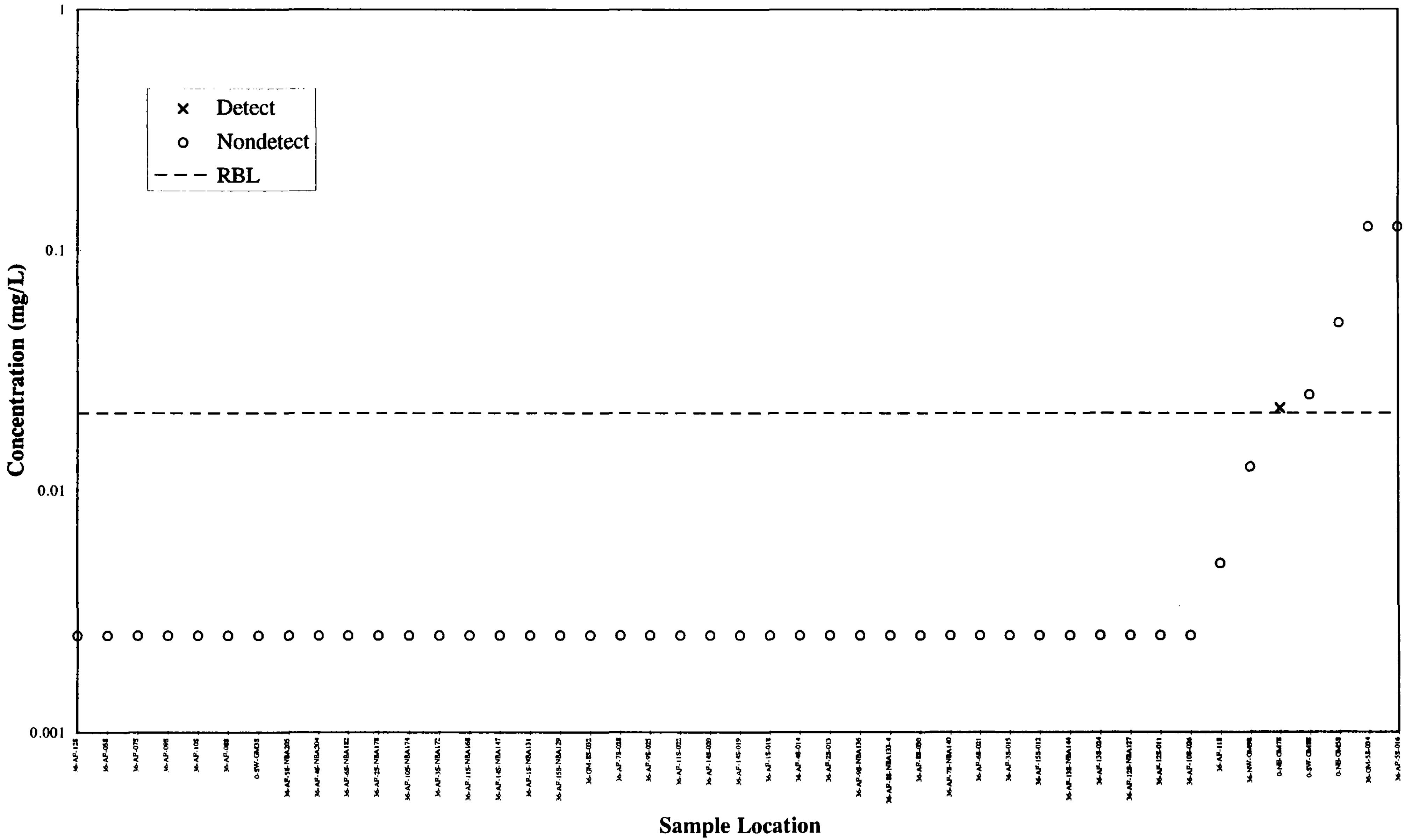

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Figure 4-62
Comparison of 1,1-Dichloroethane USG Groundwater Data to RBC Criteria

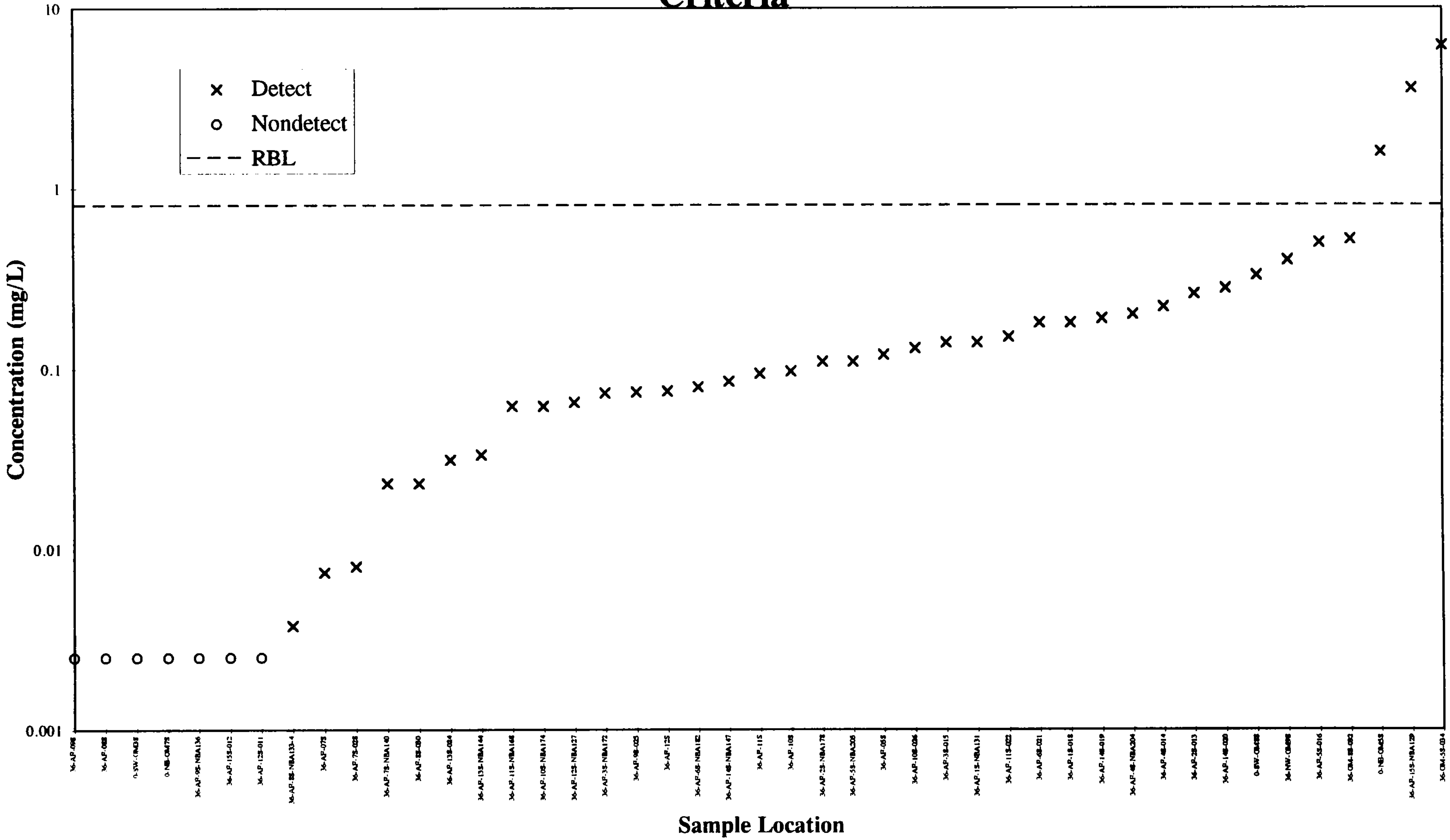

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Figure 4-63
Comparison of 1,2-Dichloroethane USG Groundwater Data to RBC Criteria

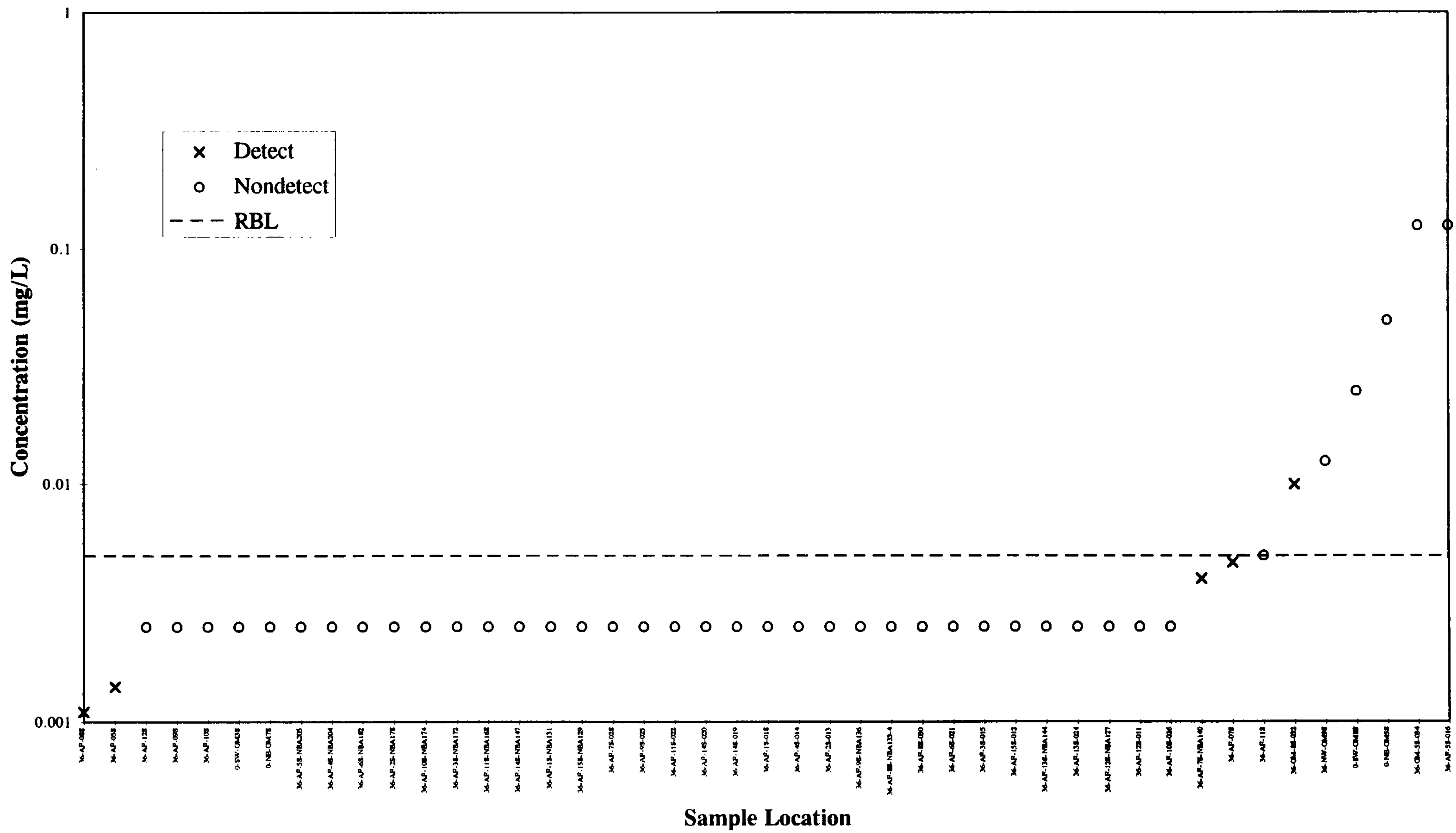

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Figure 4-64
Comparison of 1,1-Dichloroethene USG Groundwater Data to RBC Criteria

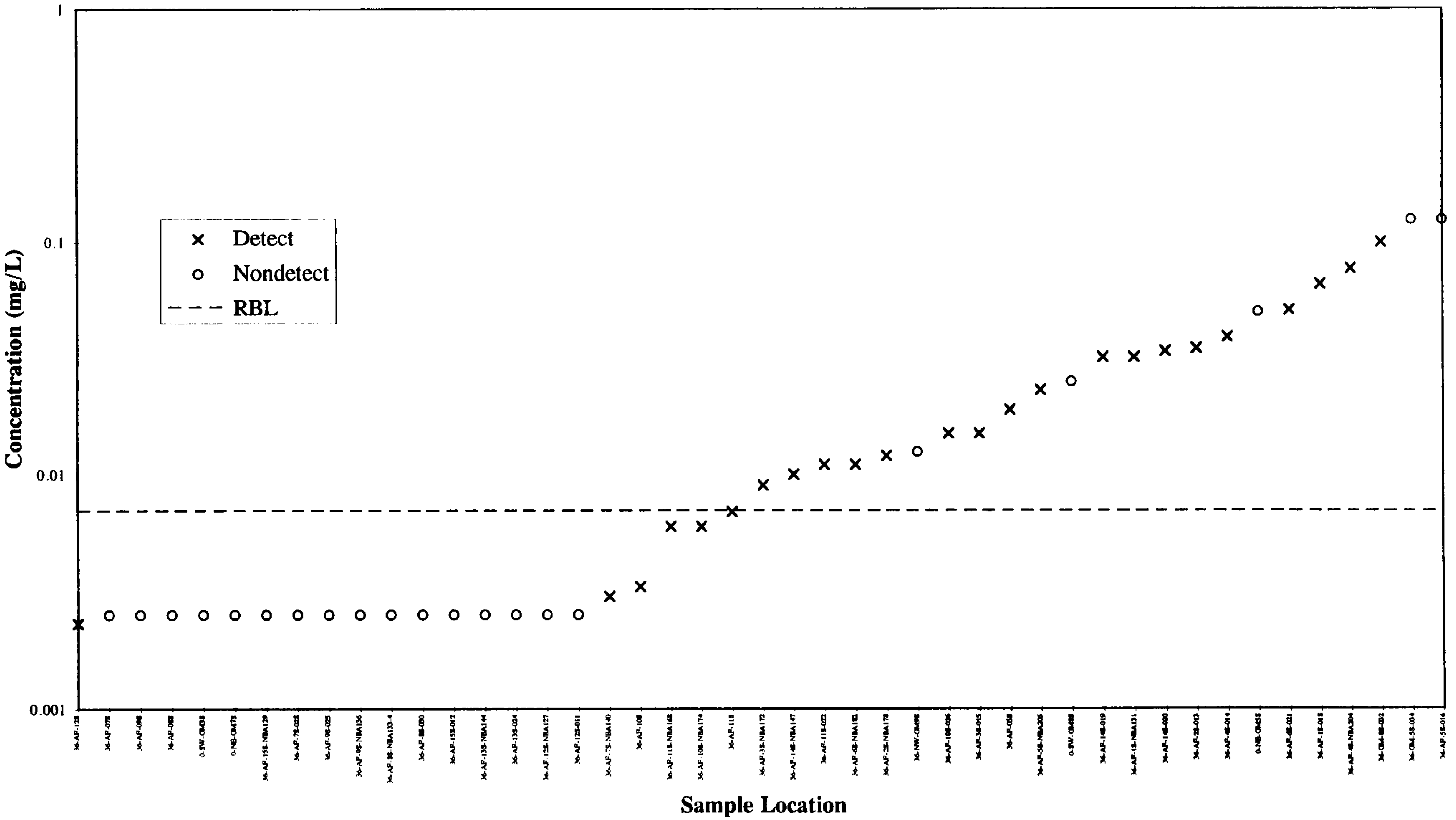

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Figure 4-65
Comparison of 1,2-Dichloroethene USG Groundwater Data to RBC Criteria

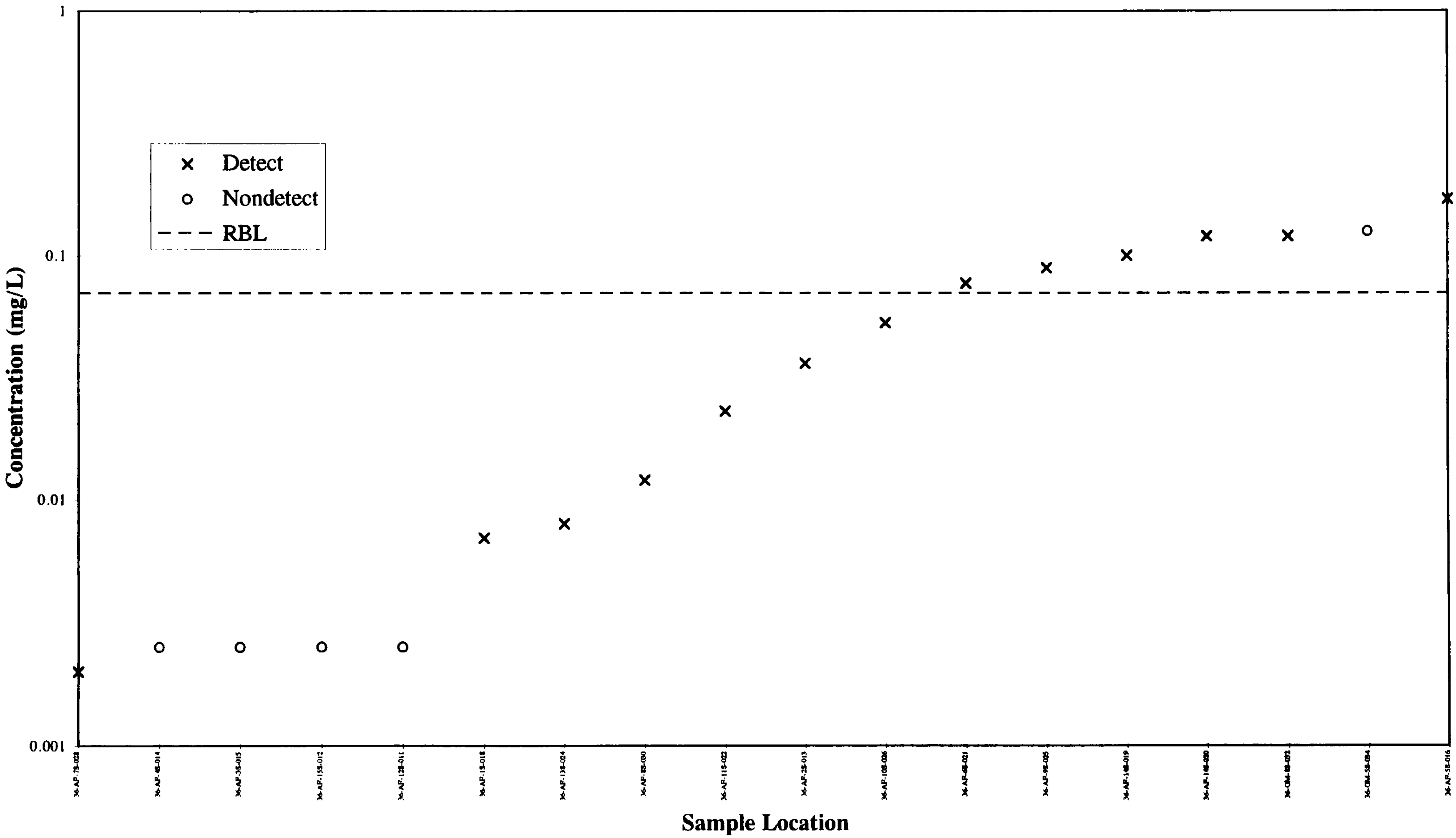

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Figure 4-66
Comparison of Cis-1,2-Dichloroethene USG Groundwater Data to RBC Criteria

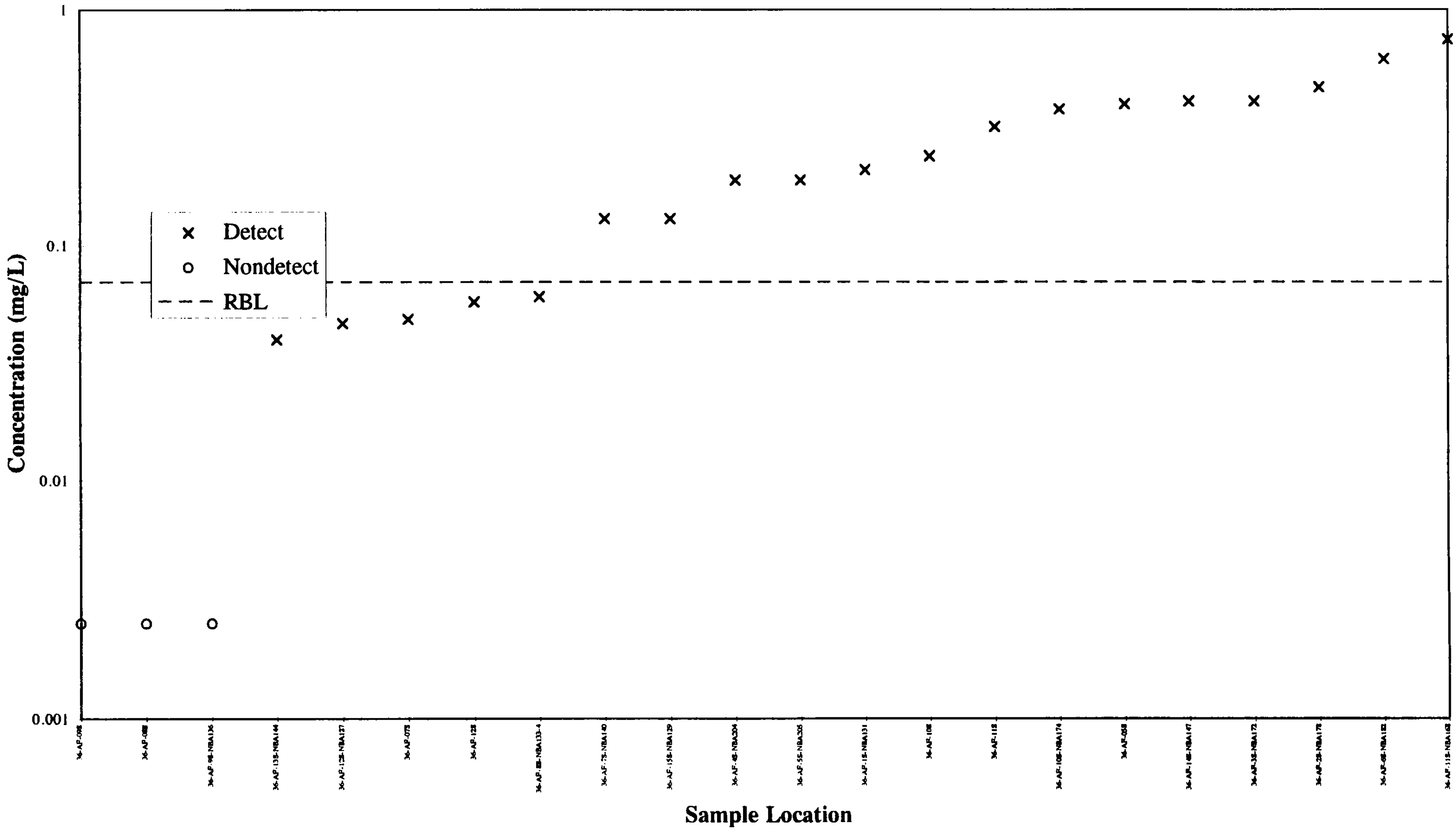

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Figure 4-67
Comparison of Trans-1,2-Dichloroethene USG Groundwater Data to RBC Criteria

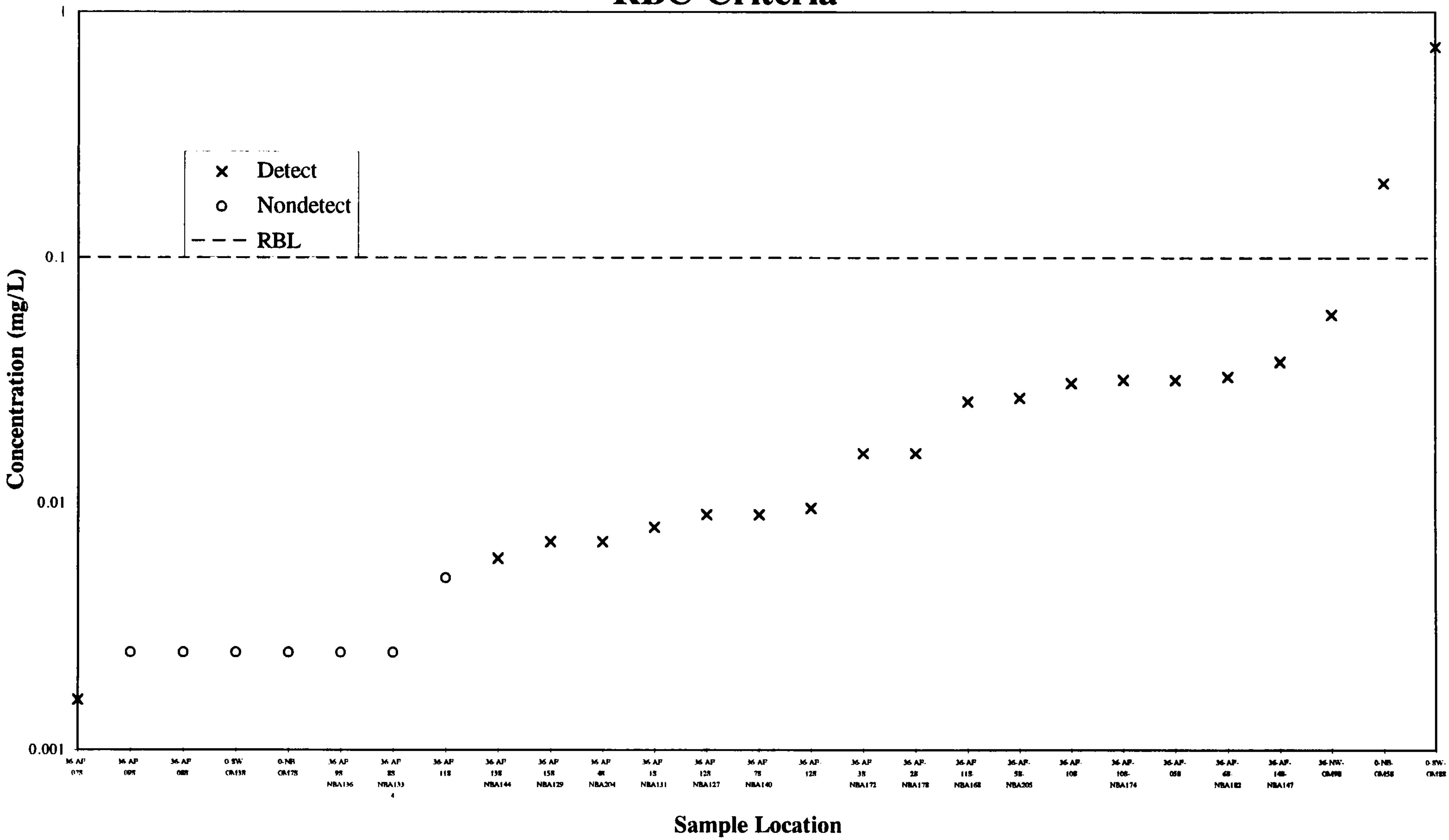

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Figure 4-68
Comparison of Methylene Chloride USG Groundwater Data to RBC Criteria

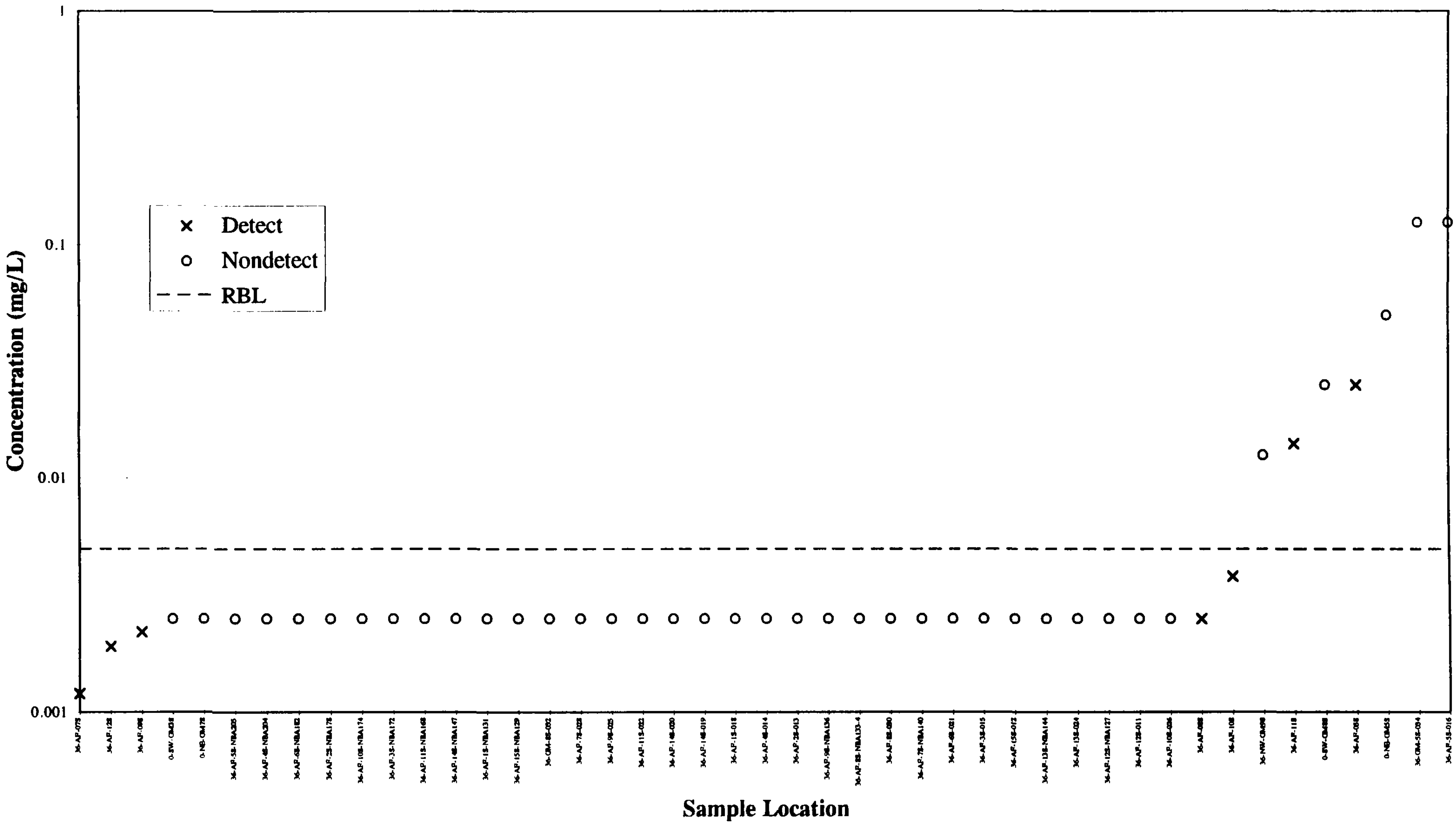

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Figure 4-69
Comparison of Nickel USG Groundwater Data to RBC Criteria

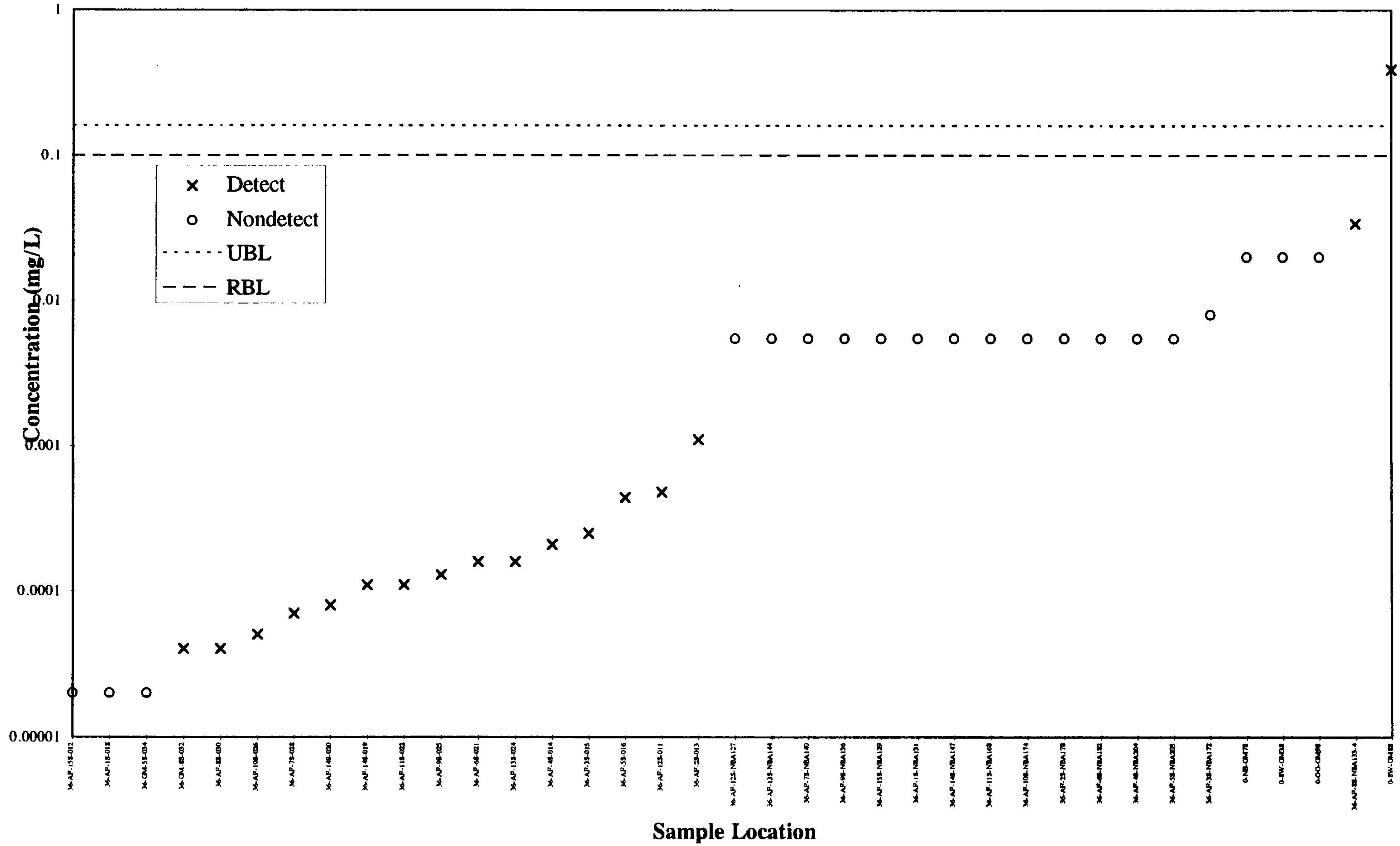

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Figure 4-70
Comparison of N-Nitrosodiphenylamine USG Groundwater Data to RBC Criteria

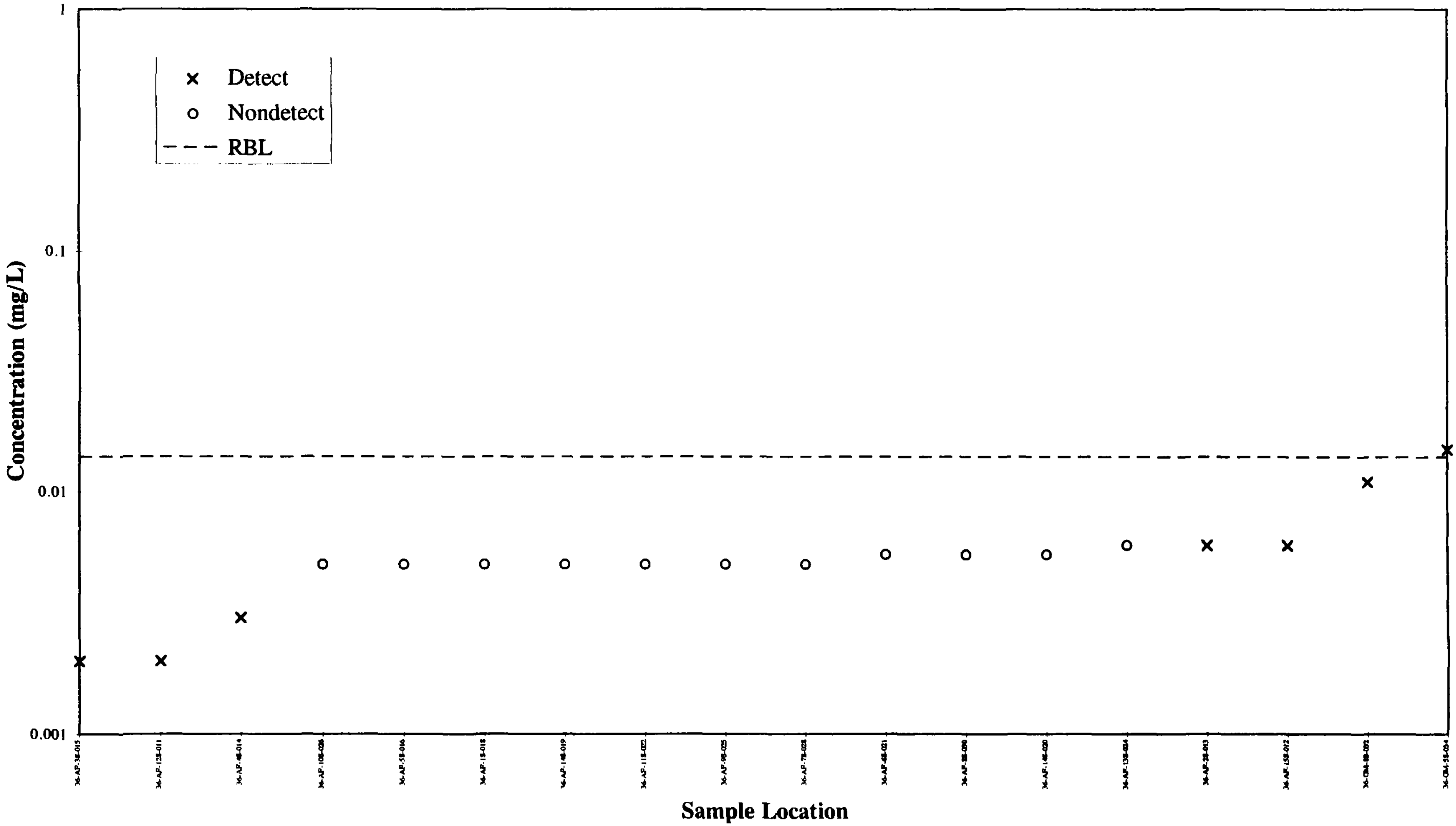

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Figure 4-71
Comparison of Tetrachloroethene USG Groundwater Data to RBC Criteria

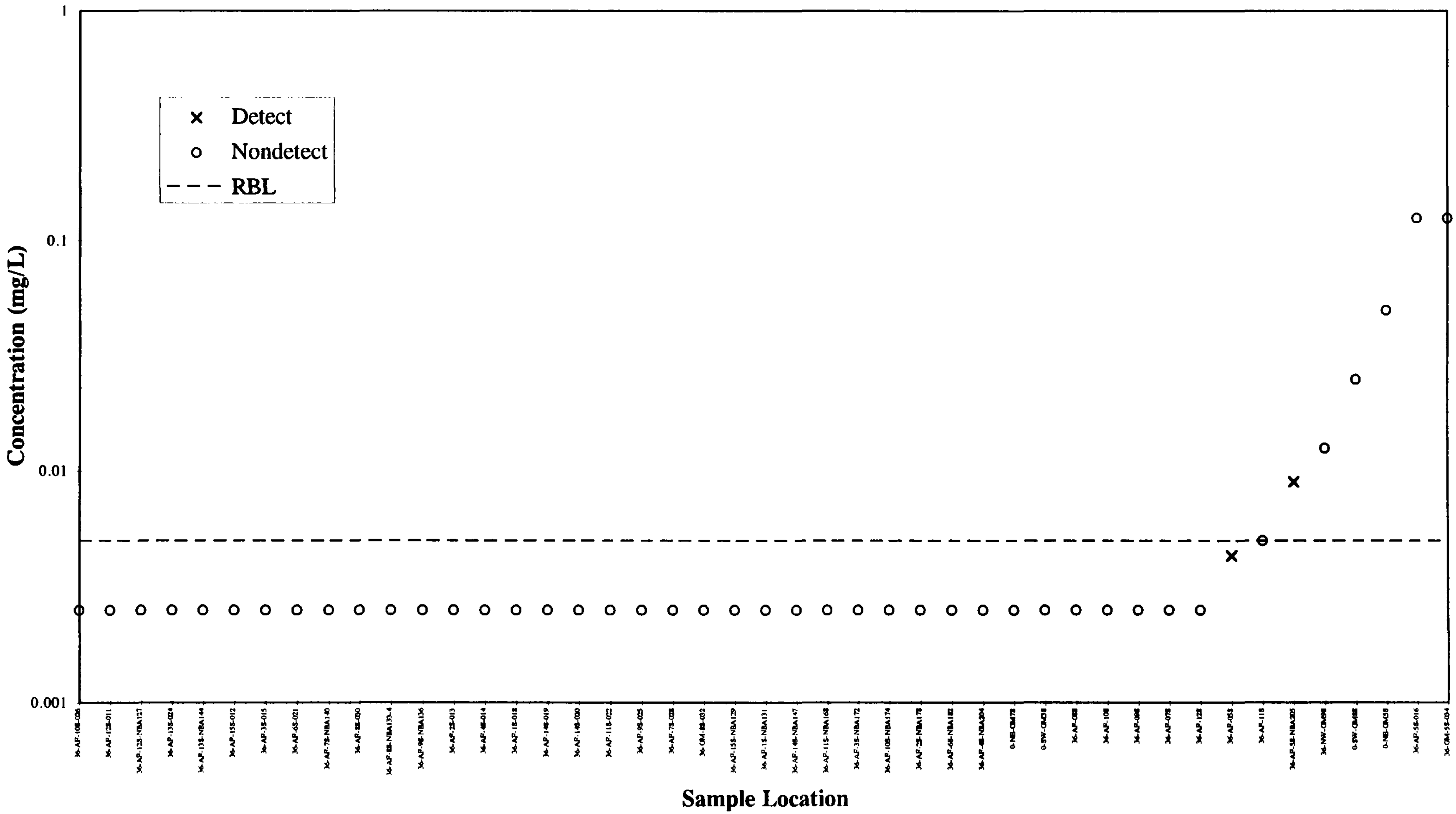

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Figure 4-72
Comparison of 1,1,1-Trichloroethane Perched Groundwater Data to RBC Criteria

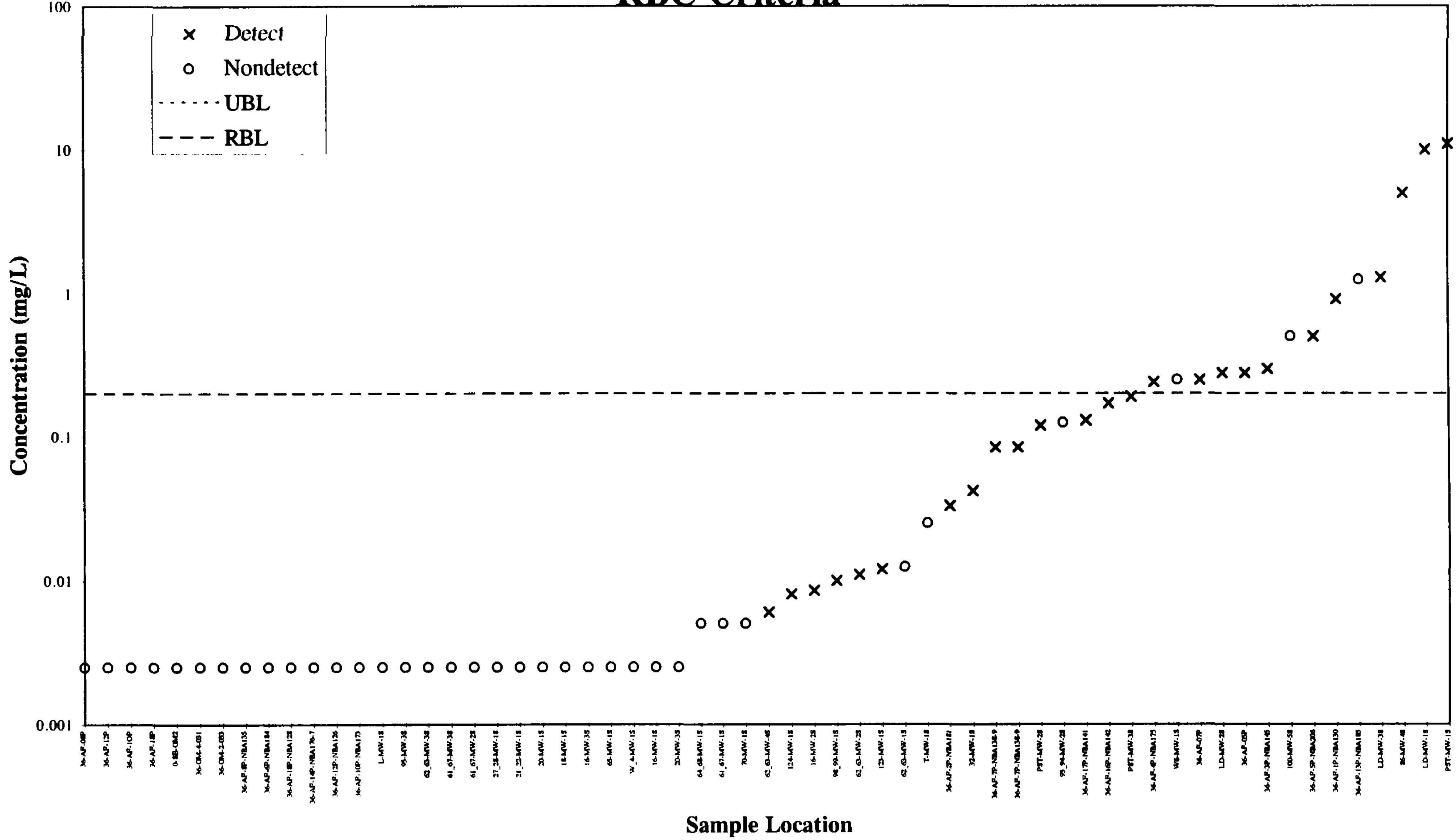

Figure 4-73
Comparison of Trichloroethene USG Groundwater Data to RBC Criteria

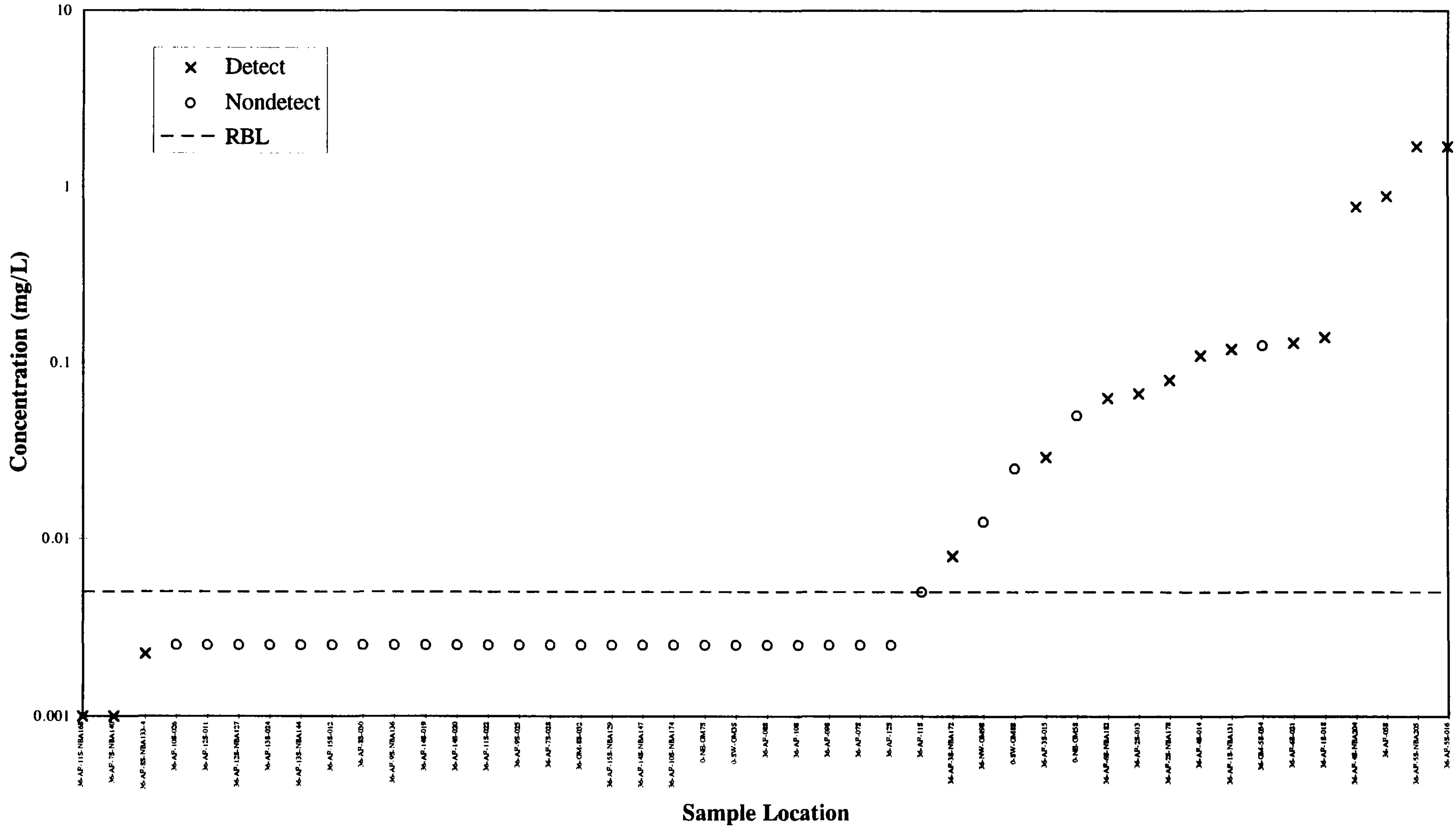

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Figure 4-74
Comparison of Vinyl Chloride USG Groundwater Data to RBC Criteria

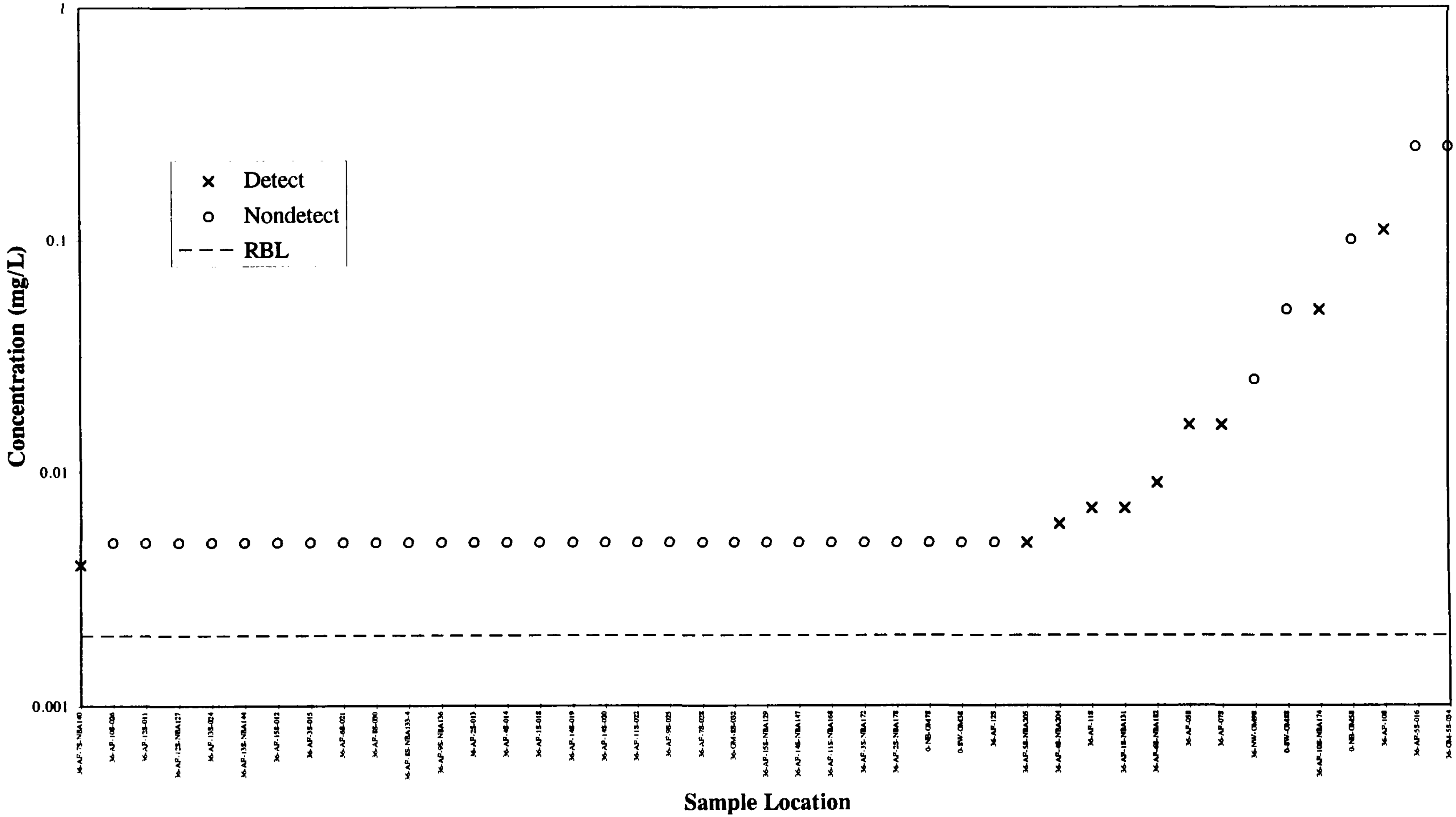

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Figure 4-75
Comparison of Benzene LSG Groundwater Data to RBC Criteria

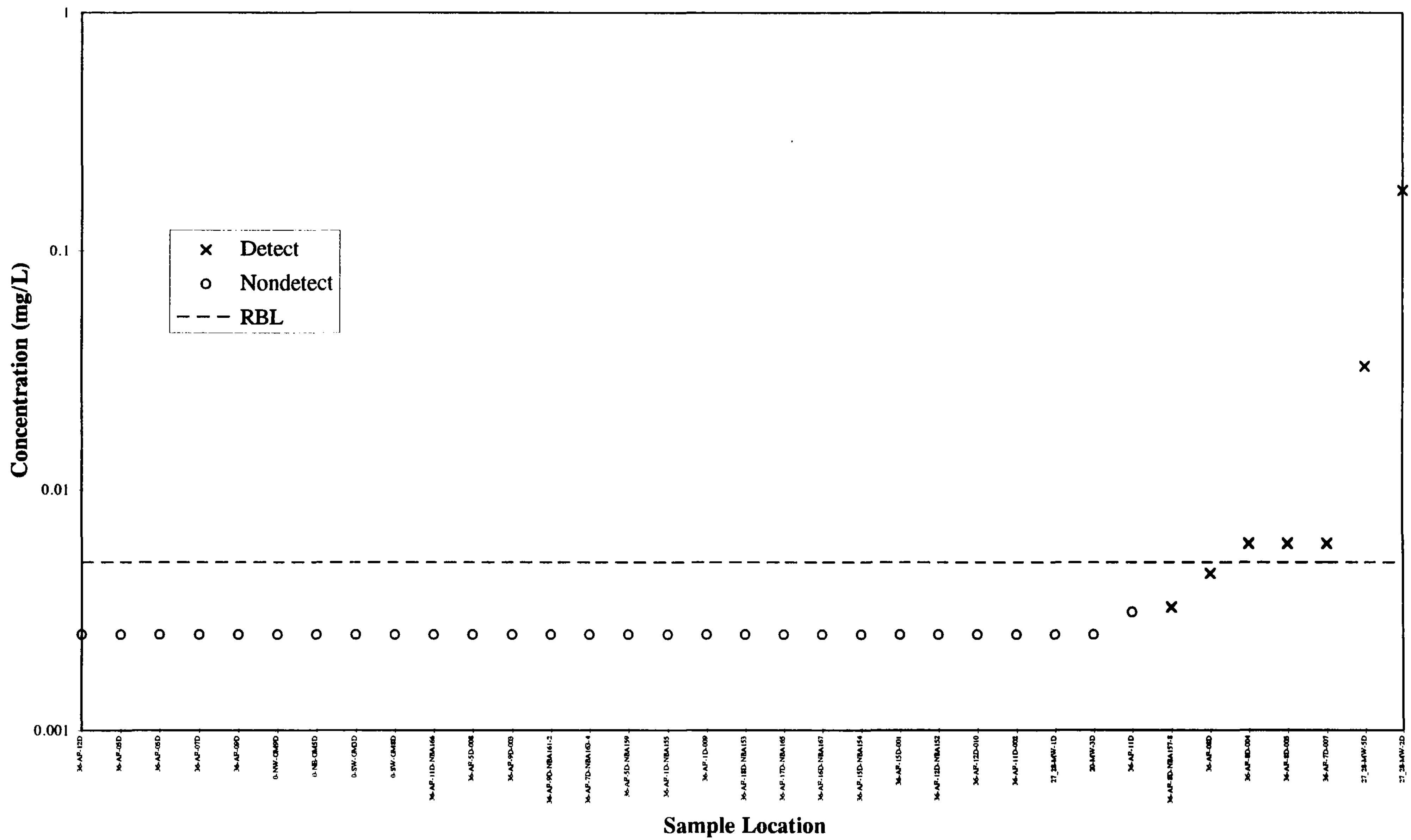

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Figure 4-76
Comparison of Bis(2-Ethylhexyl)Phthalate LSG Groundwater Data to RBC Criteria

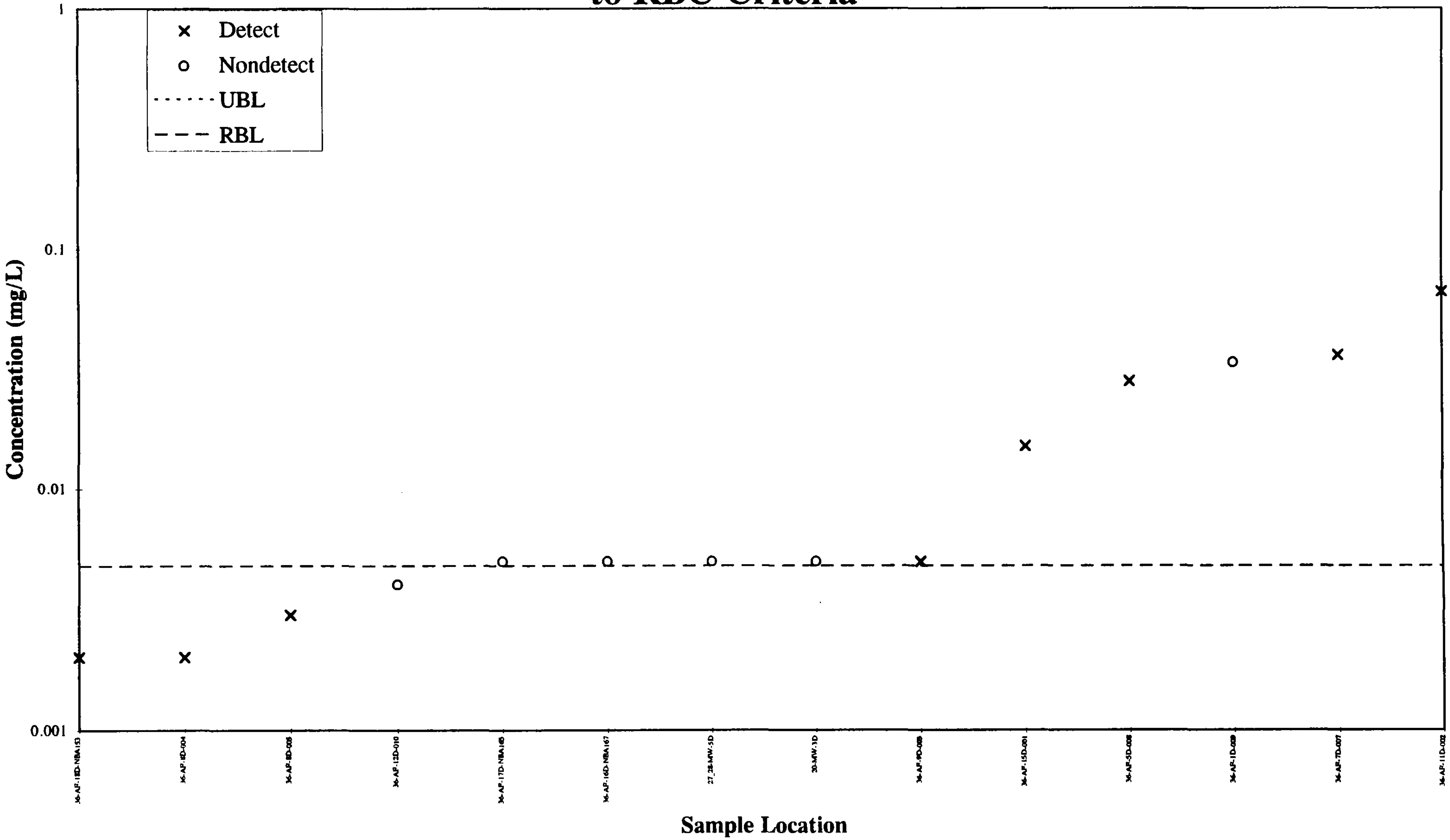

Figure 4-77
Comparison of Chloromethane LSG Groundwater Data to RBC Criteria

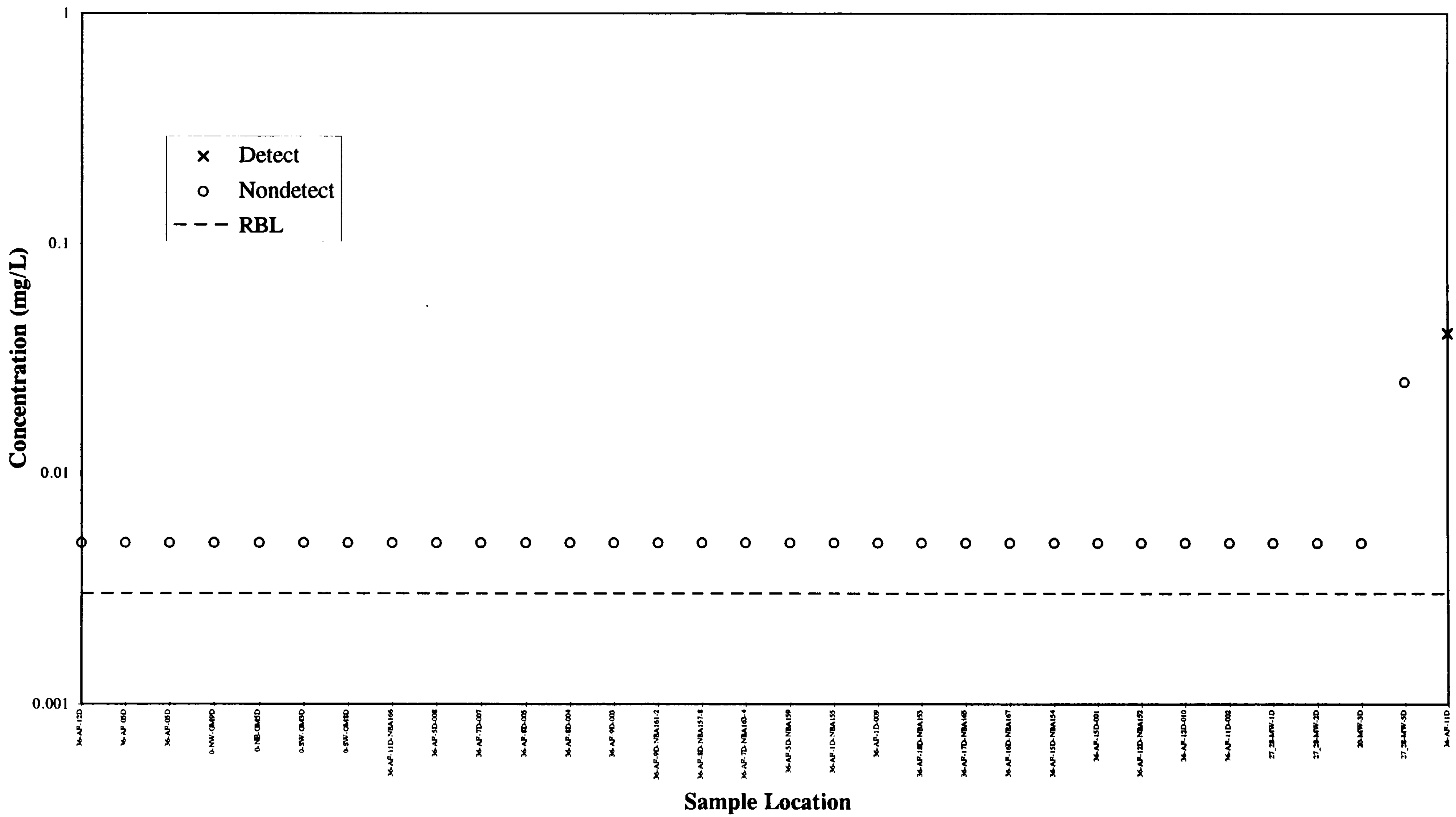

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Figure 4-78
Comparison of Chromium LSG Groundwater Data to RBC Criteria

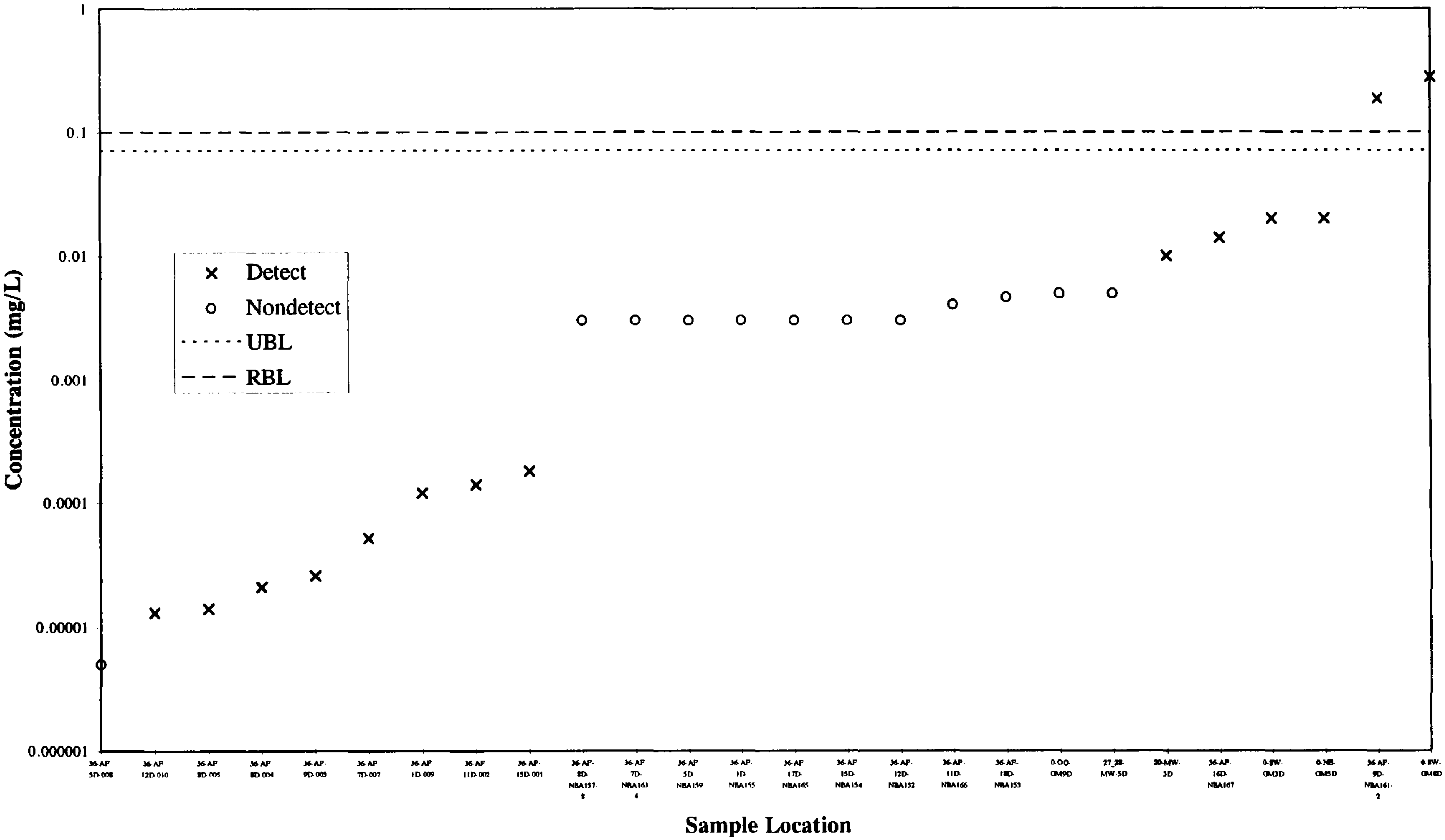

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Figure 4-79
Comparison of 1,1-Dichloroethene LSG Groundwater Data to RBC Criteria

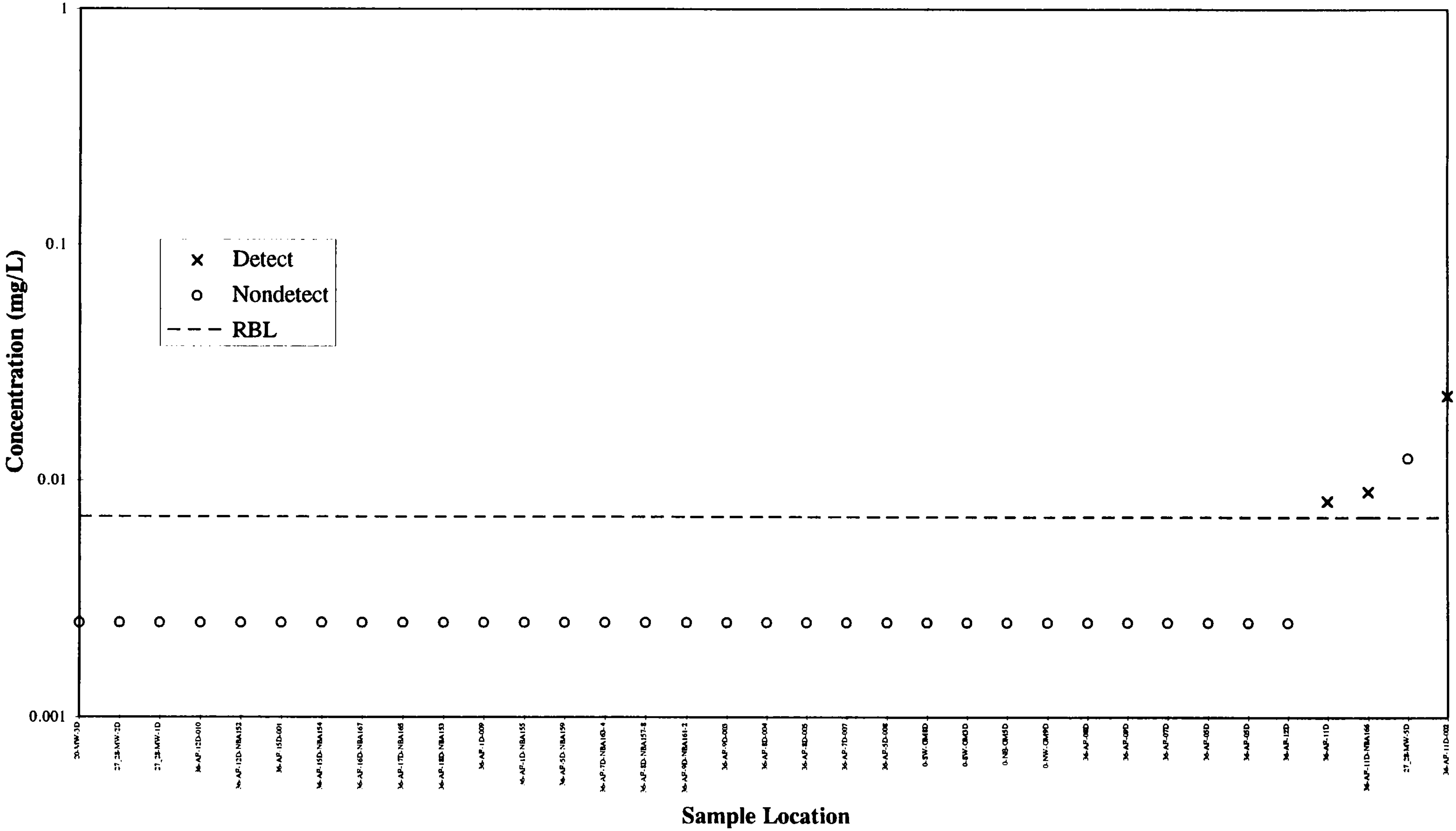

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Figure 4-80
Comparison of Cis-1,2-Dichloroethene LSG Groundwater Data to RBC Criteria

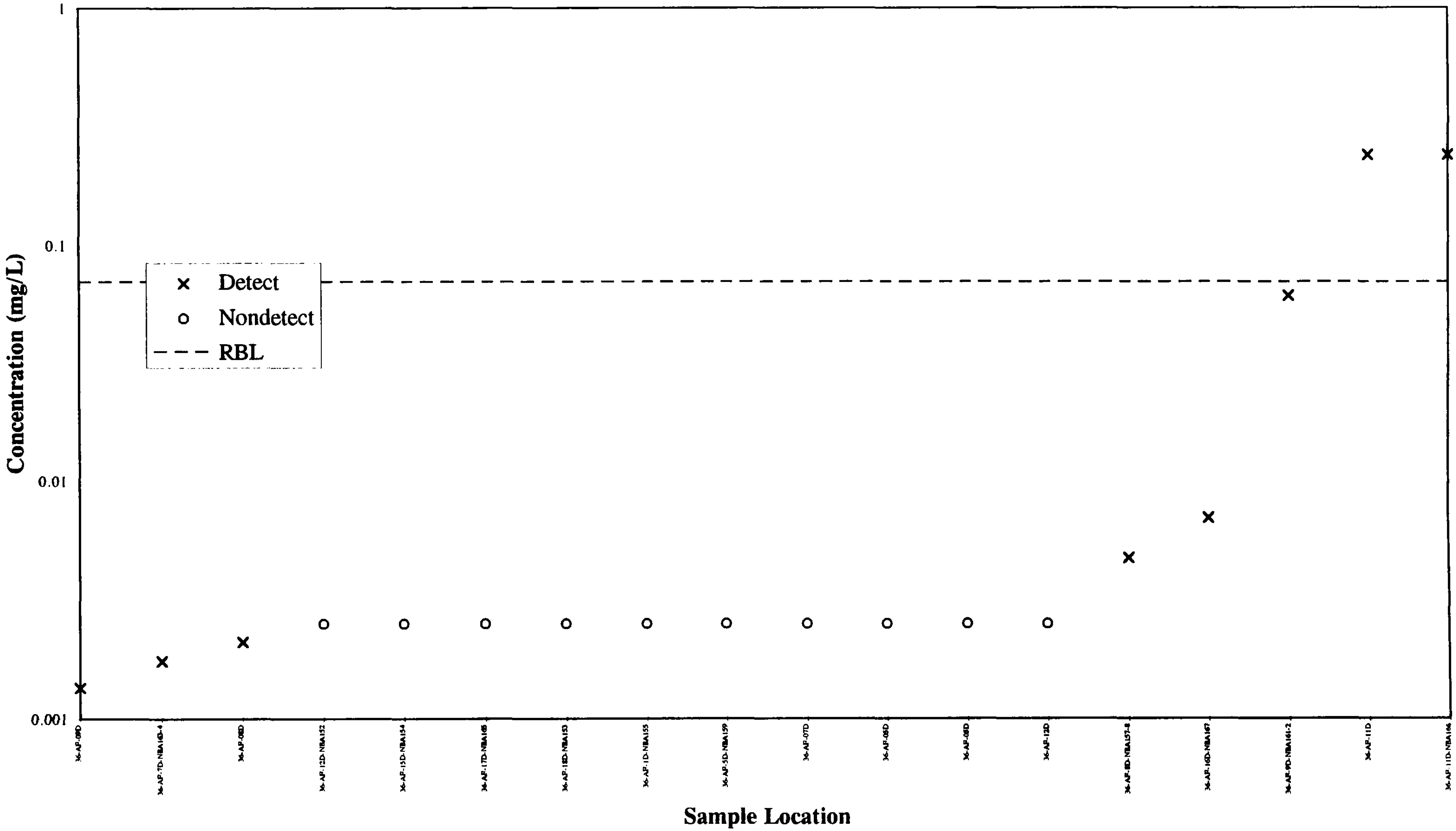

Figure 4-81
Comparison of Nickel LSG Groundwater Data to RBC Criteria

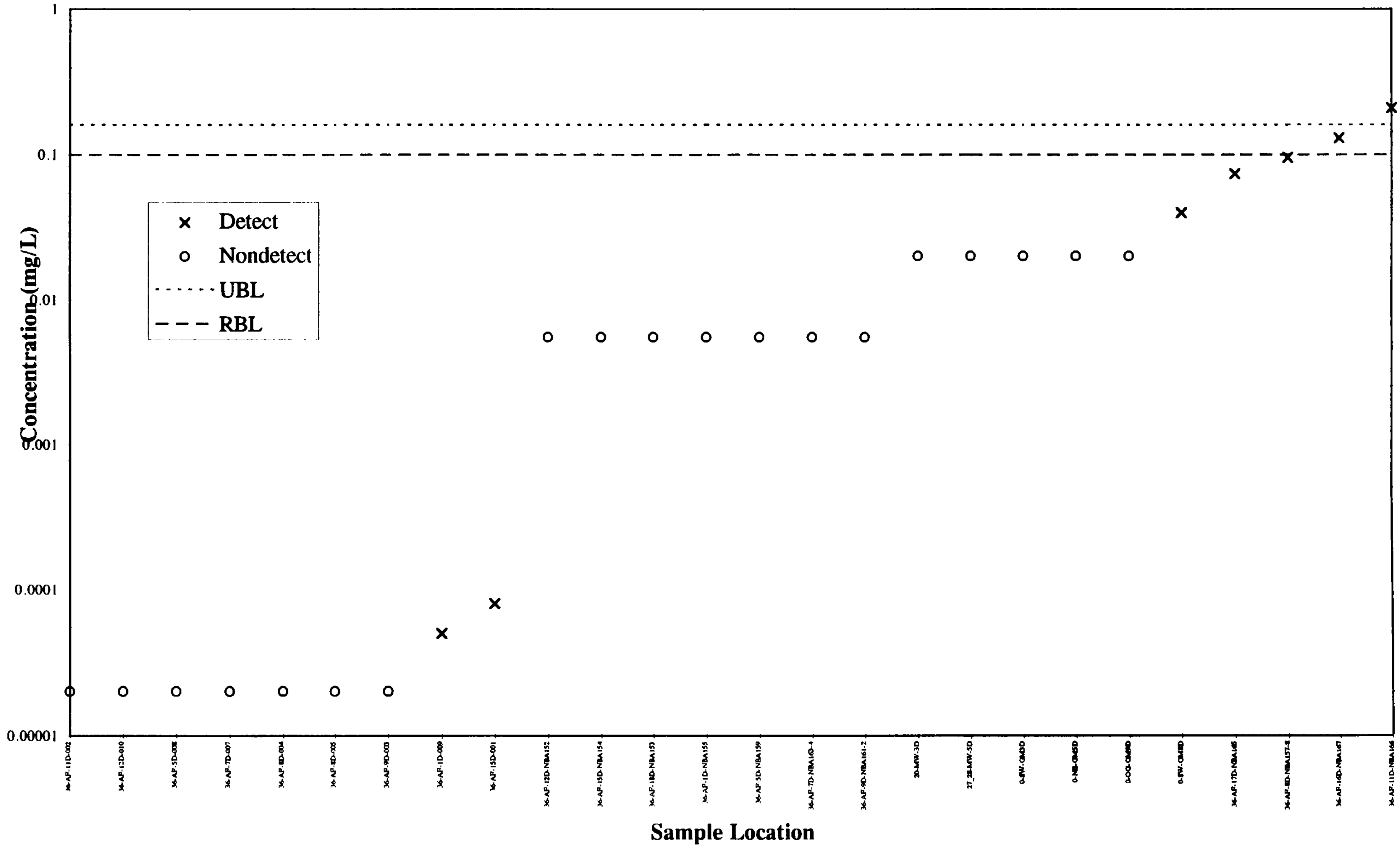

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Figure 4-82
Comparison of 1,1,2,2-Tetrachloroethane LSG Groundwater Data to RBC Criteria

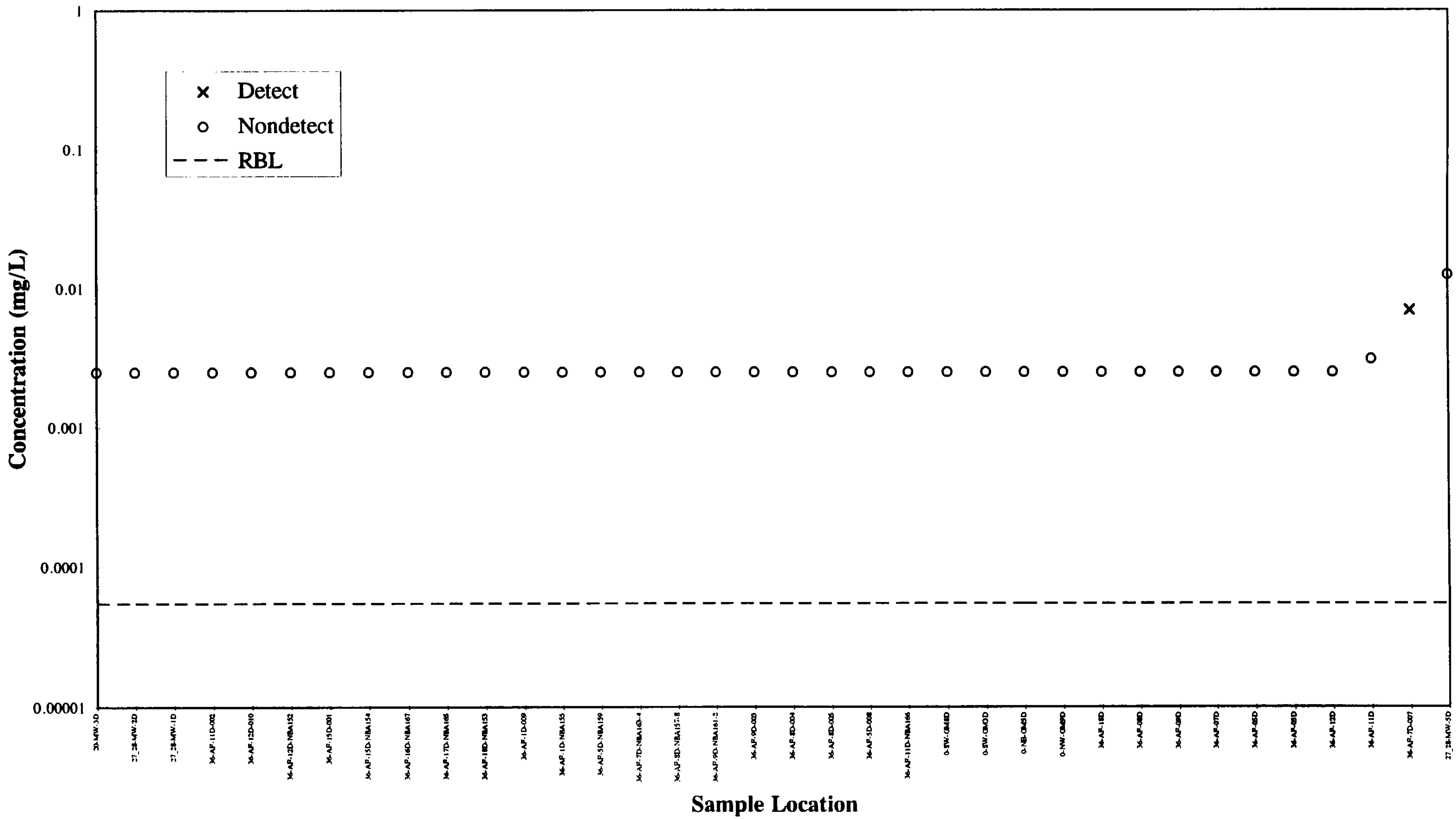

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Figure 4-83
Comparison of Trichloroethene LSG Groundwater Data to RBC Criteria

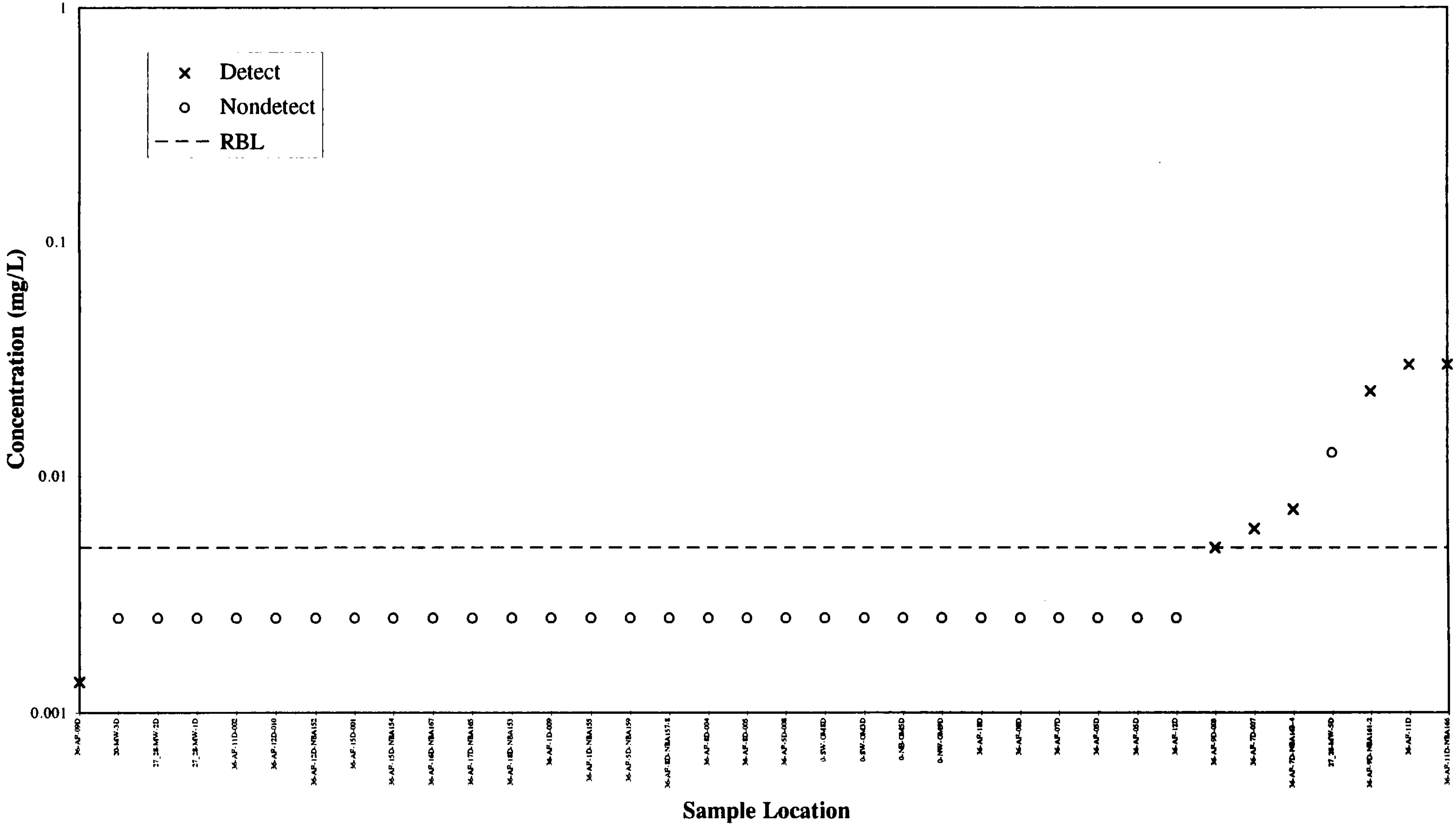

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Figure 4-84
Total Petroleum Hydrocarbon LSG Groundwater RBC Data

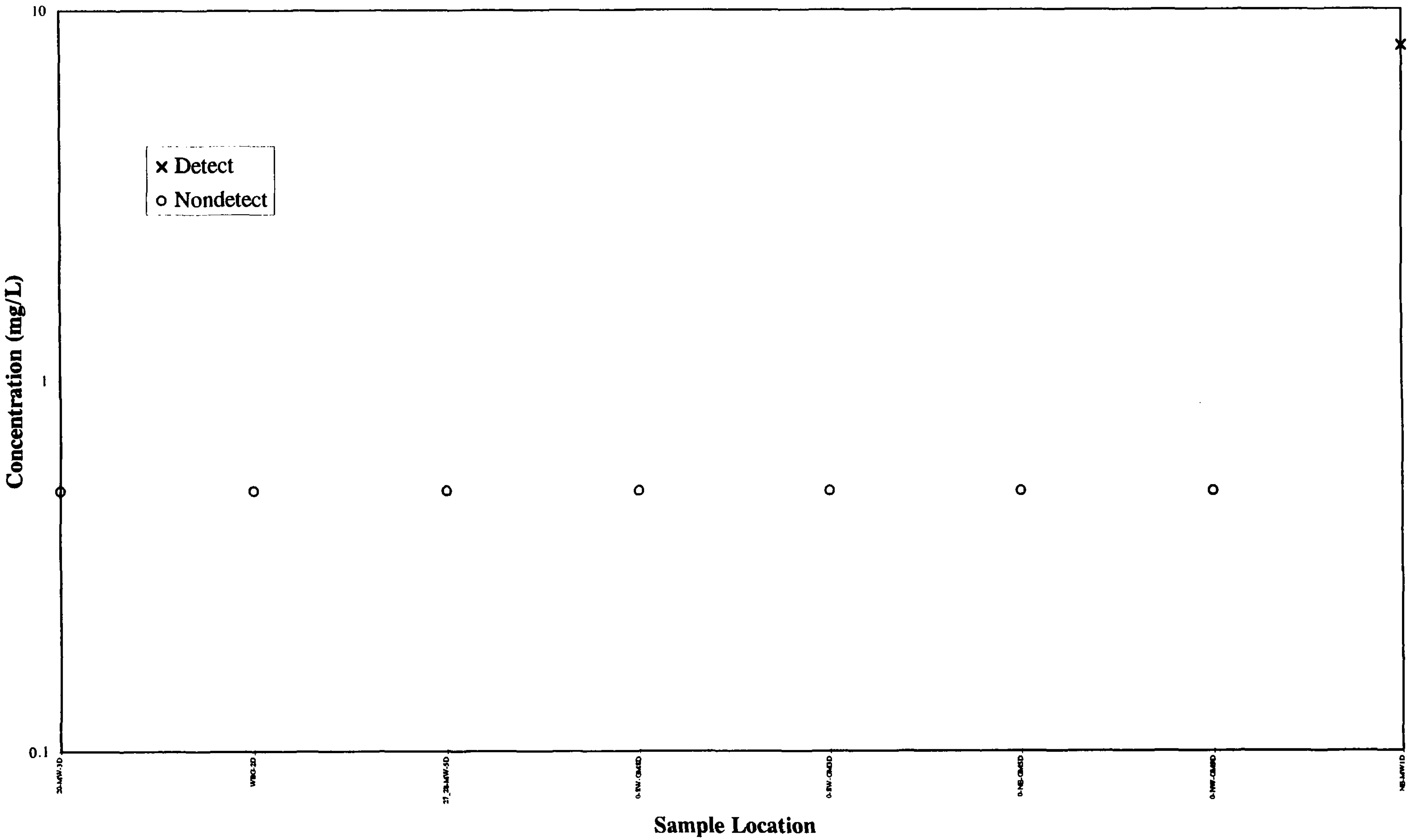

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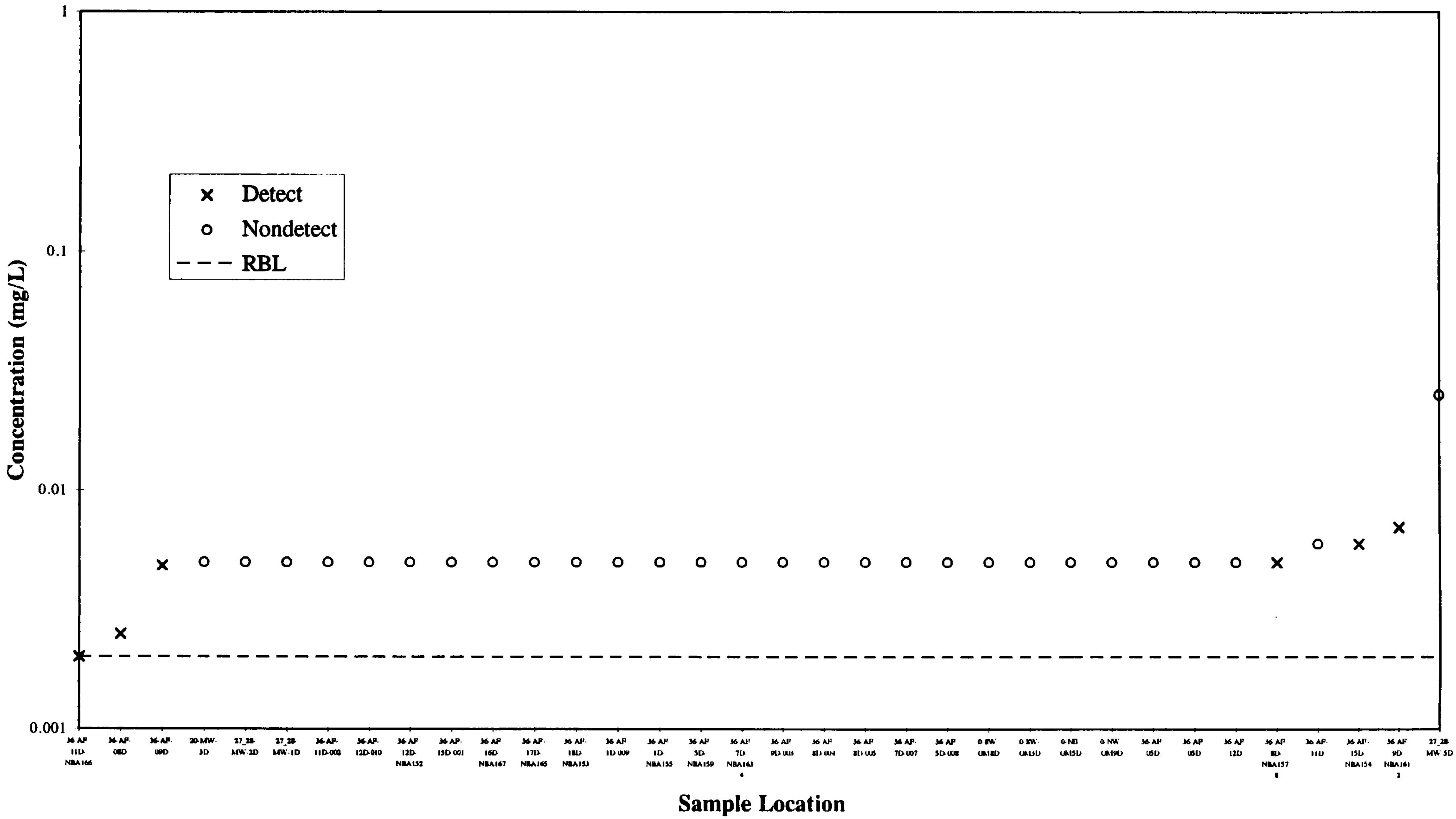
Figure 4-85
Comparison of Vinyl Chloride LSG Groundwater Data to RBC Criteria



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5.0 EXPOSURE ASSESSMENT

This section presents the exposure scenarios and proposed approach for conducting the quantitative exposure assessment. Exposure assessment is the process of estimating the magnitude, frequency, duration, and type of potential exposures to site-related chemicals. A conceptual exposure model for this site is presented (Section 5.1) which identifies release and transport processes (Section 5.1.1) and exposure scenarios (Section 5.1.2). Also presented is a discussion of exposure assessment methodology (Section 5.2), which includes the approaches to be used for determining exposure point concentrations (Section 5.2.1), fate and transport modeling (Section 5.2.2), and equations for quantifying exposure (Section 5.2.3).

5.1 Conceptual Exposure Model

A human health conceptual exposure model has been developed for the GE Aircraft Engines site which identifies potential receptors and potentially complete exposure pathways (*i.e.*, exposure scenarios). The conceptual exposure model is shown in Figure 5-1. The end product of the conceptual model is the identification of exposure scenarios that are defined by potentially exposed populations and exposure pathways. The conceptual model integrates site-specific information such as source areas, release and transport processes, points of contact with affected media, complete and incomplete exposure routes, and potentially exposed populations under current and future land use conditions. The conceptual model was developed from information obtained during the Potential Receptor Identification survey (Section 3.0) and site surveys conducted by ChemRisk® personnel.

The conceptual exposure model focused on identifying complete exposure pathways for potentially exposed populations. An exposure pathway is the means through which an individual may contact a chemical in the environment. Exposure pathways are determined by environmental conditions (*e.g.*, location of groundwater, vegetative cover, wind speed/direction), the potential for chemical migration among media (*e.g.*, soil, groundwater, or air), and by the lifestyles and work activities of potentially exposed populations. Although several potential pathways may exist, not all may be complete. For a pathway to be complete, the following four factors must exist:

(1) a source of chemical release into the environment;

(2) a release and transport mechanism (*e.g.*, volatilization to air; infiltration to groundwater, etc.) that moves the chemical from the source to other locations;

(3) a point of contact with the affected transport medium; and

(4) a means of taking the chemical into the body (exposure route) such as breathing vapors or ingesting affected media.

These four factors were considered in the conceptual exposure model. Once a source of chemical release has been identified, release and transport processes can be identified along with potential points of contact and complete exposure pathways to formulate exposure scenarios that will be the focus of the quantitative risk assessment. This process is summarized below.

5.1.1 Identification of Release and Transport Processes

The key physical processes, or mechanisms, involved in the migration (transport) of a chemical from media such as soil, groundwater, and sediments into other environmental media, as defined by the USEPA (1989a), include:

- fugitive dust generation;
- volatilization;
- surface water runoff;
- leaching (percolation);
- groundwater transport; and
- tracking.

Fugitive Dust Generation
Fugitive dust generation can result when physical forces (*i.e.*, wind erosion, construction activities, vehicular traffic etc.) act on relatively dry and bare surface material. Currently, most of the surface soil material (>80%) at the GE Aircraft Engines facility is covered by concrete pads, asphalt, roads and buildings. The presence of these barriers eliminate the possibility of fugitive dust generation. For future conditions, the possibility exists that particulates could be generated from construction activities or uncovered soils. The quantitative risk assessment will evaluate the potential inhalation hazard posed by PCOIs in soil using generic criteria presented in the *Soil Screening Guidance* (USEPA, 1996a). If PCOI concentrations are above soil screening levels, then fate and transport modeling will be performed to predict air concentrations at on- and off-site locations.

Volatilization
Volatilization represents a potential release mechanism for chemicals detected in soil and groundwater. This potential release mechanism will be evaluated for chemicals considered to be volatile as defined by a Henry's Law Constant greater than 10^{-5} <u>and</u> a molecular weight less than 200 g/mole (USEPA, 1991b).

Surface Water Runoff
Potential releases to surface water are monitored for compliance with NPDES permit requirements and, therefore, are not included in the quantitative risk assessment.

Leaching
Chemicals may migrate by leaching from soil to an underlying aquifer. The potential for this process to act as a release and transport mechanism will be determined by evaluating (1) the characteristics of the soil column and (2) the physico-chemical properties of the COIs (*e.g.*, Koc, water solubility).

Groundwater Transport
Chemicals that have leached from the soil may potentially impact groundwater. The potential for groundwater to act as a transport medium will be determined based on (1) the direction of groundwater flow, (2) the use of the aquifer under consideration, (3) the physico-chemical properties (*i.e.*, Koc, water solubility) of the COIs, and (4) fate and transport modeling. Based on the results of the RFI, site-related constituents are present in groundwater at concentrations that exceed the MCLs. Before a quantitative assessment can be completed, groundwater modeling and solute

transport analysis may be conducted, as needed, to provide information on potential receptors to groundwater and to predict potential exposure point concentrations. Therefore, this Work Plan does not elaborate on receptors and potentially complete exposure pathways for groundwater, but will be addended once a fate and transport analysis has been completed.

Tracking
Tracking is a mechanical means of transporting soil or other material from one location to another. This is usually a concern under conditions of heavy vehicular traffic on unpaved roads or construction sites where substantial amounts of soil may be transported from the source by personnel or machinery. Since the majority of the facility is covered by pavement, gravel, or buildings, the potential for transport via tracking is not considered significant.

The above release and transport processes which are determined to be both significant and part of a complete exposure pathway will be incorporated into the quantitative exposure assessment.

5.1.2 Identification of Exposure Scenarios

To determine if a complete exposure pathway exists, one must determine if there is a point of contact between an affected medium and a likely receptor. The potential for contact with a particular medium, in turn, is determined by integrating all relevant information including current and future land use, human activity patterns, demographics, zoning regulations, and future use plans. Such information has been compiled for the facility and the surrounding area in the Potential Receptor Identification Report (Section 3 of this Work Plan). The land use and associated populations are integrated with site-specific information (*e.g.*, release and transport processes, affected media, COIs, etc.) to identify the most appropriate current and future exposure scenarios for the quantitative risk assessment.

5.1.2.1 Summary of Potentially Exposed Populations

Potential receptors described in Section 3.0 are summarized in Table 5-1.

On-Site
Under current and expected future conditions, on-site exposures are expected to be limited to workers and visitors. Workers may include GE employees and contractors who may be involved in production, maintenance, or construction activities. Visitors may include individuals engaged in business activities or trespassing activities under current conditions. However, a trespasser is unlikely with the presence of security guards and fencing at the site. The general worker was selected as the representative receptor population for current conditions. It is not expected that the visitor would be exposed at levels greater than for the worker.

Off-Site
Future land use off-site is expected to be similar to current land use: a mixture of commercial/industrial, residential, agricultural, and undeveloped land. To maintain a conservative analysis, potential off-site residential exposures will be evaluated in the exposure assessment.

5.1.2.2 Potential Points of Contact

Both on- and off-site locations are considered potential points of contact with site-related constituents. Media for potential on-site contact include surface soil, subsurface soil, sediment, and groundwater. Exposure to chemicals in on-site indoor air as a result of vapor intrusion from subsurface soil and groundwater is not included as a potential point of contact. The indoor work environment is governed under OSHA regulations. Potential off-site exposures are limited to potential contact with constituents in groundwater fugitive dust emissions (future). The migration of constituents in groundwater will be evaluated using site-specific data and models that are reliably predictive of future migration. The fate and transport modeling for groundwater will be completed in conjunction with the quantitative risk assessment. Results of the fate and transport analysis will be necessary to complete the quantitative risk assessment including the identification of potentially-exposed populations and exposure pathways. Points of contact to be considered in the quantitative risk assessment are summarized below.

Affected Media	Potential Point(s) of Contact
Surface Soil	on-site
Subsurface Soil	on-site
Sediment	on-site
Groundwater	on-site off-site (to be confirmed)

5.1.2.3 Exposure Scenarios

Based on site-specific information, three exposure scenarios were considered appropriate for the GE facility: (1) an on-site general worker, (2) an on-site excavation worker, and (3) an off-site resident. On-site visitors will not be evaluated since potential exposures to this population are expected to be lower than the on-site worker. Off-site commercial/industrial populations will not be evaluated since potential exposures to these populations are expected to be lower than residents. Sensitive subpopulations identified in Section 3.5 will be evaluated if the results of fate and transport modeling indicate that areas containing sensitive subpopulations may be impacted. The potential exposure pathways to be considered for each scenario are summarized in Table 5-2.

On-Site Worker Scenarios

Two types of on-site workers are proposed for the quantitative risk assessment;

- General Workers are conservatively assumed to be present at the site on a daily basis and are potentially exposed to soil, sediment, and air (VOCs/particulates).

- Excavation Workers are assumed to conduct invasive activities at the site (*e.g.*, installation or repair of underground utilities) and may, therefore, be exposed to surface soil, subsurface soil, perched groundwater, and air (VOCs/particulates).

Off-Site Resident Scenario

Fate and transport modeling will be used to determine whether site-related constituents in groundwater could migrate to off-site locations. Fate and transport modeling will be conducted in conjunction with the quantitative risk assessment to determine potential receptors and exposure pathways. Off-site populations will also be evaluated for potential inhalation exposures that may result from fugitive dust generation at on-site locations.

5.2 Exposure Assessment Methodology

This section presents several fate and transport models that will be considered for determining exposure point concentrations (Sections 5.2.1 and 5.2.2) and algorithms used for estimating potential uptake of chemicals from site-related media (Section 5.2.3). Two exposure levels will be quantified; the RME and the MLE. By examining two levels of exposure (*i.e.*, the RME and MLE), a range of possible exposures will be provided, giving the risk manager additional information on which to base decisions. Using this approach, it will not be necessary to rely solely on worst case assumptions. Although past decisions on remediation have been directed at protecting the maximally exposed individual, recent memoranda from the USEPA indicate that the central tendency of exposure will be utilized more heavily in future agency decision making (USEPA, 1992d,e). The two exposure levels are defined below.

Reasonable Maximum Exposure

The RME is defined by the USEPA as the highest exposure that is reasonably expected to occur at a site (USEPA, 1989a). It should be noted that the intent of the RME is to provide a conservative estimate of exposure which is well above the average exposure but still within the range of possible exposures. The RME will be determined by using upper bound estimates for key parameters, for example, the 95th percentile estimates of exposure parameters and concentrations of chemicals in environmental media. The RME will be determined for each pathway in each exposure scenario and will be calculated using standard USEPA default assumptions (USEPA, 1989a, 1992a, 1989b, 1991a), information provided in the peer-reviewed literature, and site-specific information, as appropriate.

Most Likely Exposure

The MLE will be used to represent the median or average exposure in a given population. The MLE will be calculated using the median or average values for exposure parameters and concentrations of chemicals in environmental media. The MLE will be determined for each pathway in each exposure scenario using median or average exposure parameters from USEPA guidance as well as the peer-reviewed literature and site-specific information.

5.2.1 Determination of Exposure Point Concentrations

Reliable estimates of exposure point concentrations are required to calculate the magnitude of exposure to potential receptors. The concentrations of chemicals in certain media (*i.e.*, soil, groundwater, sediment) have been measured directly during the RFI and/or historical investigations and will be employed directly to quantify exposures via the ingestion and dermal contact routes for current conditions. In these cases, the arithmetic mean and 95% UCL of the mean concentrations will be used as the exposure concentrations for the MLE and RME scenarios, respectively.

5.2.2 Fate and Transport Modeling

For some media, direct measurements of chemical concentrations may not be possible, accurate, or cost effective (*e.g.*, concentrations in air). Additionally, estimates of future concentrations are often required in order to characterize potential future exposures (*e.g.*, transport of chemicals in groundwater). In these cases, it is necessary to estimate the chemical concentrations in on- and/or off-site media based upon fate and transport modeling.

Potential fate and transport processes which may be modeled in order to estimate current and future exposure point concentrations in air and groundwater include (1) vapor emissions from soil within an excavation, (2) vapor emissions from groundwater, (3) migration of chemicals from soil to groundwater, and (4) groundwater solute transport. For the air pathways (vapor emissions from soil and groundwater), the relationship between soil and air concentration is linear. Thus, for these pathways, volatilization factors will be estimated in order to simplify the dose calculations. The volatilization factor (VF) for a certain medium is the air concentration of the chemical in air due to a unit concentration in the medium of interest (USEPA, 1996a). The models proposed for use to estimate the exposure point concentrations for each of the previously listed fate and transport processes are presented below.

Vapor Emissions from Soil - Outdoor Air
There are currently two analytical models of vapor emissions from soils which have been developed for use in estimating the air concentrations of VOCs at hazardous waste sites. These models include the Hwang and Falco (1986) model used in the volatilization factor calculation by the USEPA in *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part B* (USEPA, 1991b) and *Soil Screening Guidance* (USEPA, 1996a), and the Behavior Assessment Model (BAM) developed by Jury *et al.* (1983, 1984, 1990). Both models are analytical solutions to the general equation for vapor transport through a porous medium and estimate the vapor emission flux from the soil surface. An air dispersion model must be used to estimate the air concentrations due to the vapor emission flux estimated by the models. As a screening level approach, the generic dispersion factor of 68.8 g/m^2-s per kg/m^3 (for a half-acre source) from the USEPA Soil Screening Levels will be used (USEPA, 1996a). If this approach produces unrealistic air concentration estimates, a refined air dispersion model will be used to estimate a refined dispersion factor.

The Hwang and Falco (1986) model is derived from the methods presented by Farmer and Letey (1974) and Farmer *et al.* (1980). The model attempts to quantify the extent of volatilization of organic compounds from the soil column based on the assumption that the surface of the soil column is exposed to the atmosphere. This model considers a system where a chemical is uniformly mixed within a layer of soil and volatilization occurs at the soil surface. It also assumes that vapor phase diffusion is the only transport mechanism moving volatiles from the soil column to the soil surface. This assumes no transport via nonvapor phase diffusion or mass flow due to capillary action within the soil column.

The applicability of the Hwang and Falco model to soil diffusion processes is limited to the initial and boundary conditions upon which the model is derived. The model assumes that there are no other pathways for chemical movement or loss other than vapor phase diffusion from the soil column to the soil surface (diffusion-controlled). This model does not consider other pathways such as mass flow due to capillary action, loss of chemical at the lower boundary due to leaching, redistribution of chemicals due to rain events, non-vapor phase or solution diffusion, biodegradation, photolysis, and possible co-distillation at the soil surface. The model assumes zero vertical movement or loss from the lower boundary over an infinite time period, and the boundary conditions specify that the depth of the soil column is infinite. This assumption loses applicability with decreasing depth of the actual impacted soil, and with increasing time of simulation. Over long time periods, such as those typically evaluated for long-term exposures (approximately 25 to 30 years), this model does not attain mass balance since it does not account for mass loss due to volatilization.

The Jury volatilization model developed by Jury *et al.* (1983, 1984, 1990) is an analytical vapor emission model which is suitable for finite sources or can be modified to evaluate infinite sources. It has been designed as a screening tool to assess the volatilization potential of a large number of compounds under standard soil and environmental conditions. The Jury volatilization model quantifies the volatilization losses of an organic compound under standard soil conditions. The compound is assumed to move by vapor or liquid diffusion and by mass flow under the influence of steady upward or zero water flow while undergoing first-order degradation and linear equilibrium adsorption.

The USEPA has replaced the modified Hwang and Falco equation with the simplified equation developed by Jury *et al.* (1990) for use in estimating the volatilization factor for the *Soil Screening Guidance* (USEPA, 1996a). The major theoretical differences between the models are differences in how the two models estimate effective diffusivity, how the models handle phase partitioning, and the ability of the Jury volatilization model to simulate finite emission sources (EQ and Pechan, 1994; USEPA, 1996a). The effective diffusivity term in the modified Hwang and Falco equation considers the effect of soil moisture on tortuosity only, and phase partitioning is expressed solely in terms of the sorbed and vapor phases at equilibrium. The effective diffusion coefficient used in the the Jury volatilization model not only accounts for the effect of soil moisture on tortuosity but also includes the effect of liquid-phase diffusivity and expresses phase partitioning in terms of sorbed, vapor and liquid phases (Jury *et al.*, 1983, 1984, 1990). Therefore, the Jury volatilization model will be used to estimate the volatilization factor for vapor emissions of COIs from soil to air.

Vapor Emissions from Groundwater - Indoor Air During Domestic Use
Currently two approaches exist for estimating the concentrations of VOCs in indoor air due to volatilization from tap water during showering, a chemical-specific approach developed by McKone and Knezovich (1991) based on experimental measurements of trichloroethene in tap water, and an approach developed by Andelman (1990) which is presented by the USEPA in *Risk Assessment Guidance for Superfund, Part B* (USEPA, 1991b) and used to estimate preliminary remedial goals based on exposures to groundwater.

McKone and Knezovich (1991) performed experiments to measure the fraction of the dissolved chemical trichloroethylene, a VOC, transferred from tap water in showers to indoor air. This paper quantified the transfer efficiency of the compound from water to air. The theoretical dependence of transfer efficiency on basic mass transfer properties makes plausible estimates of relative transfer efficiency through the scaling of mass transfer parameters from one chemical to another. In an earlier work, McKone (1987) has derived a relationship that can determine the transfer efficiency of one chemical relative to that for another under the same physical conditions. These properties include the Henry's law constant and diffusion coefficients in air and water. The premise that transfer efficiency is limited by liquid-phase mass transfer (which is more temperature insensitive) and not by gas-phase mass transfer (which is more sensitive) is supported by the lack of temperature dependence observed in McKone an Knezovich's measurements of transfer efficiency. The methods for estimating indoor air concentrations due to VOC emissions from household water use based on the work by McKone and Knezovich (1991) are applicable to a wide range of VOCs and are dependent on chemical-specific physico-chemical properties.

Andelman (1990) derived an equation that defined the relationship between the concentration of a chemical in household water and the average concentration of a volatilized chemical in air. The Andelman approach considered all uses of household water (*e.g.*, laundering, showering, dish washing). A default "volatilization" constant (K) was derived by the USEPA based on several assumptions (USEPA, 1991b). This constant had an upper bound value of 0.5 L/m^3. To derive the default constant K, the USEPA assumed that the volume of water used in a residence for a family of four is 720 L/day, the volume of the dwelling is 150,000 L and the air exchange rate is 0.25 m^3/hr. It was also assumed that the average transfer efficiency weighted by water use is 50 percent.

Unlike the McKone and Knezovich approach (1991), this default volatilization factor is not dependent on site-specific or chemical-specific considerations (USEPA, 1991b). In addition, the assumption of 720 L/day as a water use rate is 1.3 times greater than the 95th percentile water use rates presented in the published literature (McKone and Bogen, 1991; Finley *et al.*, 1993), and the total house air exchange rate of 0.25 m^3/hr is 1,200 times smaller than the minimum value presented in the literature (McKone and Bogen, 1991; Finley *et al.*, 1993). These assumptions lead to an ultraconservative estimate of volatilization from tap water during household uses. Because of the gross conservatism of the Andelman (1990) volatilization factor, its insensitivity to site-specific or chemical-specific data, and the validation of the McKone and Knezovich (1991) approach using actual measured data, the McKone and Knezovich method will be used to estimate chemical-specific volatilization factors for indoor air due to emissions from tap water during household use, if required.

Vapor Emissions from Groundwater - Vapor Intrusion into Buildings

The generation and transport of vapor from the water table, movement through the overlying soils, and final emission to the atmosphere are complex processes. A conservative model of vapor emission was developed combining transient modeling of volatilization from the water table as a continuously stirred tank reactor (CSTR) with that of a steady-state model of vapor emissions through soil using Fick's law of diffusion (Farmer *et al.*, 1980; Lyman *et al.*, 1982). The model is conservative in its prediction of vapor flux since it overpredicts the rate of volatilization. These two approaches are combined to produce an equation for the time-averaged vapor emission mass flux from surface soil. This time-averaged flux is used in conjunction with an indoor mass balance box model to estimate indoor air concentrations.

A simplistic indoor mass balance box model can be used to conservatively estimate the indoor air concentrations The emission rate fluxes at the bottom of the floor are obtained from the Farmer and

Lyman models described above. An assumption is made on the crack factor (0.1%) of the total floor area to estimate the emissions inside the building. The indoor air concentration is then determined by assuming the air in a room to be a well mixed. The steady state indoor air concentration can then be determined by dividing the indoor emission rate by the air exchange rate.

Migration of Chemicals from Soil to Groundwater
The migration of chemicals from soil to groundwater, if required, will be analyzed using a two-tiered process. Initially, a simple site-specific calculation based on the linear equilibrium partitioning approach presented in the *Soil Screening Guidance* (USEPA, 1996a) will be performed to determine if any groundwater impacts exist. If necessary, a detailed site-specific methodology, utilizing more complex fate and transport models will be used to estimate groundwater concentrations due to COIs migrating from soil. The simple site-specific calculation uses a standard linear equilibrium soil/water partition equation (Dragun, 1988; USEPA, 1996a) to estimate chemical concentrations in soil leachate. This leachate concentration is then multiplied by a dilution factor which represents the reduction in soil leachate concentrations due to mixing with groundwater to provide an estimate of on-site groundwater concentrations. Site-specific and chemical-specific values will be used in this equation to calculate a screening-level estimate of the concentrations of COIs in groundwater due to leaching from soil.

This methodology is very conservative and based on simplifying assumptions about the release and transport of chemicals in subsurface soils. Some of the more significant assumptions are: (1) steady-state concentrations will be maintained in groundwater over the exposure period of interest; (2) chemicals are uniformly distributed throughout the zone of contamination; (3) soil impacts extends form the surface to the water table; (4) the receptor point is at the edge of the site; (5) the receptor well is within the plume; (6) the aquifer is unconsolidated and unconfined (surficial); (7) aquifer properties are homogeneous and isotropic; (8) there is no adsorption or degradation of chemicals in the aquifer and; (9) Non-Aqueous Phase Liquids (NAPLs) are not present at the site (USEPA, 1996a).

Based on the results of the screening-level estimates, a more detailed site-specific approach may be used to more accurately estimate groundwater concentrations of COIs due to migration from soil. For this approach, complex fate and transport models will be used with detailed site-specific data to estimate COI concentrations in groundwater due to migration from soil (USEPA, 1996a). This approach represents the highest level of site-specificity in evaluating the impacts of soil leachability and will account for the hydrogeologic, climatologic, and source characteristics of the site (USEPA, 1996a). Two models will be considered for use in this site-specific evaluation: (1) the MULTIMED (MULTIMEDia exposure assessment model) and (2) SESOIL (SEasonal SOIL compartment model) unsaturated zone models. The choice of model for each site will be determined based on data availability and site-specific considerations. A short description of each model follows.

MULTIMED was developed as a multimedia fate and transport model to simulate contaminant migration from a waste disposal unit. In MULTIMED, a landfill module is used to simulate infiltration of waste into the unsaturated and saturated zones. Flow in the unsaturated zone and for the landfill module is simulated by a one-dimensional, semi-analytical module that considers the effects of dispersion, sorption, volatilization, biodegradation, and first-order chemical decay. Flow in the saturated zone is simulated using a one-dimensional model that considers three-dimensional dispersion, linear adsorption, first-order decay, and dilution due to recharge. Mixing in the underlying saturated zone is based on the vertical dispersivity specified, the length of the disposal facility parallel to the flow direction, the thickness of the saturated zone, the groundwater velocity, and the infiltration rate.

SESOIL is a one-dimensional, finite difference flow and transport model developed for evaluating the movement of contaminants through the vadose zone. The model contains three components: (1) hydrologic cycle, (2) sediment cycle, and (3) pollutant fate cycle. The model estimates the rate of vertical solute transport and transformation from the land surface to water table. Up to four layers can be simulated by the model and each layer can be subdivided into ten compartments with uniform soil characteristics. Hydrologic data can be included using either monthly or annual data options. Solute transport is simulated for groundwater and surface runoff including eroded sediment. This model considers equilibrium partitioning to soil and air phases, volatilization from the surface layer, first-order chemical degradation, biodegradation, cation exchange, hydrolysis, and metal complexation and allows for a stationary free phase.

Groundwater Solute Transport
Similar to the soil leachability modeling, the migration of COIs in groundwater will be characterized using a two tiered approach, if required. Initially, a screening-level, analytical groundwater solute transport model will be used to estimate the dilution of soil leachate into groundwater within unconsolidated sediments and to identify any potentially impacted off-site groundwater receptors. A more refined, numerical groundwater solute transport model will be used to determine groundwater concentration trends across the site and offsite if necessary.

The screening-level, analytical groundwater solute transport model must meet the following criteria:

(1) The model must account for advection, dispersion, retardation and degradation processes.

(2) The model must be, at least, two-dimensional.

(3) The data requirements for the model must be sufficiently basic, *i.e.*, the model should only require input of basic aquifer properties, such as, porosity, hydraulic conductivity, hydraulic gradient, retardation coefficient, and dispersion coefficients.

Two analytical groundwater solute transport models which meet these requirements are the MYGRT model (EPRI, 1989) and the USEPA's AT123D model (USEPA, 1988a). MYGRT is a groundwater solute transport model that was developed by Electric Power Research Institute (EPRI) to simulate groundwater transport of both organic and inorganic constituents (EPRI, 1989). This model considers key physical processes such as advection, dispersion, linear equilibrium sorption and first-order transformation or degradation. The MYGRT model can function as either a one- or two-dimensional model. AT123D (Analytical Transient 1-, 2-, and 3-Dimensional) model is a groundwater solute transport that has been developed by the USEPA to simulate the migration of both organic and inorganic constituents in groundwater (USEPA, 1988a; 1988b). This model can predict chemical movement in 1-, 2-, and 3-dimensions. In addition, this model can account for advective and dispersive transport, volatilization, retardation, and degradation processes (USEPA, 1988a). This model is typically coupled with SESOIL to estimate groundwater concentrations at a distance from a source of soil leachate.

For circumstances that necessitate a more refined groundwater solute transport model, the SWIFT (Sandia Waste-Isolation Flow and Transport) model will be considered. SWIFT is a fully-transient, three-dimensional model which simulates the flow and transport of solutes in porous and fractured media (Reeves *et al.*, 1986). This model is capable of accounting for advective transport, dispersion, retardation, and degradation in groundwater.

5.2.3 Pathway-Specific Intake Equations and Exposure Parameters

The following section provides the calculation algorithms which will be used to quantify intake (or dose) for each COI. A description of the value used for each exposure parameter is also provided. For both the RME and MLE evaluations, estimates of the lifetime average daily doses (LADDs) and average daily doses (ADDs) will be quantified. The LADD defines a dose level that is distributed (averaged) over an entire lifetime, rather than a specific incremental exposure period. Unlike the LADD, the ADD is not averaged over an entire lifetime. The RME LADDs and ADDs will be used to calculate upper-bound estimates of the increased potential cancer and noncancer risks, respectively, while the MLE LADDs and ADDs will be used to estimate the average cancer and noncancer risks, respectively.

Intake Equations
The equations to be used for quantifying exposure to COIs in site media and the rationale for each point estimate value to be used for both the RME and MLE evaluations are discussed below. Proposed exposure parameters are summarized in Table 5-3. In general, exposure values were taken from established USEPA guidance documents including: *RAGS* (USEPA, 1989a), *Exposure Factors Handbook* (USEPA, 1989b), *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (USEPA, 1991a), and *Dermal Exposure Assessment: Principles and Applications* (USEPA, 1992a). These documents provide guidance for the selection of exposure parameters and will be relied upon along with site-specific information and information from the peer-reviewed scientific literature to identify appropriate RME and MLE exposure parameters.

Potentially exposed populations associated with the site and surrounding area include workers (general, maintenance, and excavation) and residents. Table 5-3 presents the proposed exposure parameter values for these population types. Exposure parameters are presented for the potential exposure routes (*i.e.*, ingestion, inhalation, and dermal contact) and points of contact (*i.e.*, soil, sediment, groundwater).

Exposure Via Soil Ingestion:

$$LADD\ /\ ADD = \frac{C * IS * CF * EF * ED}{BW * AT} \qquad (1)$$

Exposure Via Dermal Contact with Soil/Sediment:

$$LADD\ /\ ADD = \frac{C * AF * ABS * SA * CF * EF * ED}{BW * AT} \qquad (2)$$

Exposure Via Inhalation of Volatiles:

$$LADD\ /\ ADD = \frac{C * IR * EF * ED * ET * CF}{BW * AT} \qquad (3)$$

Exposure Via Ingestion of Groundwater:

$$LADD\ /\ ADD = \frac{C * IW * EF * ED}{BW * AT} \qquad (4)$$

Exposure Via Dermal Contact with Groundwater:

$$LADD\ /\ ADD = \frac{C * Kp * SA * CF * EF * ED * ET}{BW * AT} \qquad (5)$$

Exposure Parameters and Values:

ABS (Dermal Absorption Factor, unitless) - Dermal absorption fraction (ABS) is used to determine the amount of a chemical which is absorbed through the skin from soil. ABS terms have been experimentally determined for only a few chemicals (USEPA, 1992a). In the absence of experimental data, ABS values of 0.25, 0.1, and 0.01 are proposed for volatiles, semi-volatiles, and inorganics, respectively. Chemical-specific ABS values are provided in Table 5-4 for all PCOIs.

ADD (Average Daily Dose, in terms of mg/kg-day) - The dose averaged over the exposure duration which is used to evaluate potential noncarcinogenic effects.

AF (Soil Adherence Factor, in terms of mg/cm²) - Several studies have evaluated the amount of soil or dust that is likely to be in contact with skin. These studies (Lepow *et al.*, 1975; Roels *et al.*, 1980; Que Hee *et al.*, 1985; Driver *et al.*, 1989; Yang *et al.*, 1989) were evaluated in USEPA's *Dermal Exposure Assessment: Principles and Applications* (USEPA, 1992a), and it was determined that a range of values from 0.2 mg/cm^2 to 1.5 mg/cm^2 appears to be plausible. The report also concluded that since these studies are based on measurements of soil adherence to hands, they may in fact overestimate soil adherence for other body parts. Consequently, the USEPA believes that the lower end of the range (0.2 mg/cm^2) may be the best value to represent an average overall soil adherence factor and that 1.0 mg/cm^2. may be a reasonable upper-bound value (USEPA, 1992a). Therefore, the value of 1.0 mg/cm^2 will be used for the RME estimates and 0.2 mg/cm^2 for the MLE.

AT (Averaging Time, in days) - Seventy years is assumed to be the average lifetime for humans (USEPA, 1989a) for the LADD calculations. For the ADD calculations, the averaging time will be set equal to the exposure duration.

BW (Body Weight, in terms of kg) - Standard USEPA default body weights will be used for exposure scenarios for both the RME and MLE evaluations. A body weight of 70 kilograms will be used for adults (USEPA, 1989a; 1991a).

C (Concentration of chemical in media, units are medium-specific) - Concentrations will be represented by either the mean concentration detected in on-site media for MLE evaluations, or the 95% UCL concentration for RME evaluations. For soil and sediment (Equations 1-2), the concentration term is expressed as mg/kg, for air (Equation 3) as mg/m^3, for water (Equations 4 and 5) as mg/L.

CF (Conversion Factor, route- and medium-specific) - Conversion factors are used in some of the dose equations when the parameter units are not directly comparable. For example in Equations 1 and 2, a conversion factor of 10^{-6} kg/mg will be used; in Equation 3 a conversion factor of 1 day/24 hours will be used.

ED (Exposure Duration, in terms of years) - The exposure duration is the amount of time (years) an individual may be exposed to site-related chemicals. Typically, this term describes the occupational tenure for industrial/commercial scenarios or residency time for residential scenarios. For industrial/commercial scenarios, this parameter describes the number of years that an individual will spend performing work-related activities. Data from the Bureau of Labor Statistics were used to describe the exposure duration for workers based upon the distribution of worker tenure in the United States. An MLE exposure duration of 4.2 years will be used (*i.e.*, 50th percentile of industrial tenure time) (USEPA, 1989a). An RME exposure duration of 25 years will be used (USEPA, 1989a; 1991a).

For residential scenarios, the exposure duration parameter will be the fraction of a lifetime an individual might spend at their home. National data were used for both the RME and MLE evaluations. The exposure duration for the MLE will be the 50th percentile of the residential tenure distributions of owner occupied housing in the United State (9 years) (USEPA, 1989b). The exposure duration for the RME will be the 90th percentile of this distribution (30 years) and is equal to the USEPA default value.

ET (Exposure Time, in hours/day) - The exposure time is the amount of time (hours) an individual may be exposed to site-related chemicals each day. A standard exposure time for workers is 8 hours/day and is applicable to both the RME and MLE scenarios. Residential exposure times are dependent on the exposure scenario evaluated. Exposure times of 0.12 hours (MLE) and 0.2 hours (RME) for showering exposures (USEPA, 1989a) to 24 hours may be appropriate.

EF (Exposure Frequency, in terms of days/year) - Exposure frequency is the amount of time (days/year) an individual may spend potentially exposed to site-related chemicals. For the general worker MLE and RME evaluations, a value of 250 days/year will be used in the absence of site-specific information (USEPA, 1991a). Exposure frequencies for the maintenance and excavation workers will be based on site-specific information. The USEPA default value of 350 days/year will be used for the both RME and MLE residential evaluations (USEPA, 1989a; 1991a). This value accounts for time spent at home and allows for an absence of two weeks per year (USEPA, 1989a; 1991a).

IW (Ingestion Rate for Drinking Water, in terms of L/day) - Tap water intakes for adults were obtained from USEPA (1989a). The average (1.4 L/day) and 90th percentile (2.0 L/day) intakes for adults will be used for MLE and RME conditions, respectively.

IR (Inhalation Rate, in terms of m^3/day) - Inhalation rates for the RME evaluations will be based on USEPA default criteria of 20 m^3/day (USEPA, 1991a). For the MLE evaluations, the 50th percentile of the breathing rate distribution provided by Layton (1993) of 15 m^3/day will be used.

IS (Ingestion Rate for Soil Sediment, in terms of mg/day) - There are little or no reliable quantitative data available for estimating adult soil ingestion rates. USEPA risk assessment guidance suggests a soil ingestion rate of 100 mg/day for adults, based primarily on Hawley's 1985 published estimate of 65 mg/day. In addition, Hawley estimated a soil ingestion rate of 480 mg/day during yard work. However, Hawley's estimates were not based on quantitative tracer data. Current USEPA risk assessment guidance (USEPA, 1991a) also suggests a soil ingestion rate of 50 mg/work day for adults in commercial/industrial settings, based on the results reported in Calabrese's preliminary adult soil ingestion study (Calabrese *et al.*, 1990). However, Calabrese *et al.* (1991) have since determined that the soil ingestion rates reported in this adult study were invalid, and that the 50 mg/day value is likely to be an overestimate (Calabrese *et al.*, 1991). Hence, neither of the Agency recommended estimates of adult soil ingestion rates are strongly supported by the literature. Since the validated median soil ingestion rates determined for children in the Calabrese study are 16 mg/day and 55 mg/day for Zr and Ti, respectively, it is reasonable to expect that adult soil ingestion rates are less than 10 mg/day, as suggested by Paustenbach (1987) and Calabrese *et al.* (1991). Accordingly, for the applicable adult residential and commercial/industrial MLE evaluations, a 10 mg/day soil ingestion rate will be used. For the adult commercial/industrial RME evaluations, the USEPA default value of 50 mg/day will be used.

Kp (Permeability Coefficient, in terms of cm/hr) - This term is used to determine the dose of a chemical which is absorbed through the skin from water. Chemical-specific values for Kp are available from USEPA's *Dermal Exposure Assessment: Principles and Applications* (USEPA, 1992a). Values proposed for use in the risk assessment are provided in Table 5-4.

LADD (Lifetime Average Daily Dose, in terms of mg/kg-day) - The dose averaged over a 70-year lifetime which is used to evaluate potential carcinogenic effects.

SA (Skin Surface Area, in terms of cm^2 or cm^2/day) - The total skin surface area (average of men and women; 18,150 cm^2) was obtained from USEPA (1989a). USEPA's *Dermal Exposure Assessment: Principles and Applications* (1992a) states that 10 to 25% of the total skin surface area is available for contact with soil throughout the year. Therefore, a value of 25% of the total skin surface area will be used for RME evaluations and 12.5% of the total skin surface area, one-half the RME value, will be used for the MLE for all receptors. Skin surface area exposed to groundwater will be evaluated on a scenario-by-scenario basis.

TABLE 5-1
POTENTIALLY EXPOSED POPULATIONS AND EXPOSURE MEDIA THAT WILL BE EVALUATED IN THE QUANTITATIVE RISK ASSESSMENT

	Receptor Population	
Medium	**Current**	**Future**
Onsite		
Air	General Worker	General Worker
Surface Soil	General Worker	General Worker
Total Soil (Surface & Subsurface)	Excavation Worker	General Worker Excavation Worker
Groundwater	Excavation Worker	Excavation Worker
Sediment	General Worker	General Worker
Offsite		
Groundwater	To Be Determined	To Be Determined
Air	Resident	Resident

TABLE 5-2
SUMMARY OF POTENTIALLY-EXPOSED POPULATIONS AND EXPOSURE PATHWAYS THAT WILL BE EVALUATED IN THE QUANTITATIVE RISK ASSESSMENT

Exposure Medium	Receptor	Exposure Route	Potentially Complete Pathway?	Comments
On-Site Surface Soil	General Worker	Dermal Contact Ingestion Inhalation	Yes Yes Yes	Dependent on location of contamination.
On-Site Total Soil[a]	Excavation and General Worker	Dermal Contact Ingestion Inhalation	Yes Yes Yes	Dependent on location of contamination.
On-Site Sediment	General Worker	Dermal Contact Ingestion Inhalation	Yes Yes Yes	Dependent on location of contamination.
On-Site Groundwater	Excavation Worker	Dermal Contact Ingestion Inhalation	Yes No Yes	No ingestion because industrial use only. On-site groundwater is not currently used.
Off-Site Groundwater	TBD	Dermal Contact Ingestion Inhalation	TBD TBD TBD	Dependent on depth and location of contamination

a Total soil is surface and subsurface soil.
TBD To be determined through fate and transport modeling of constituents in groundwater.

TABLE 5-3
EXPOSURE PARAMETER VALUES

Parameter	Resident Child MLE	Resident Child RME	Resident Adult MLE	Resident Adult RME	General Worker MLE	General Worker RME	Excavation Worker MLE	Excavation Worker RME
BW (kg)	15[b]	15[b]	70[b]	70[b]	70[b]	70[b]	70[b]	70[b]
Averaging Time, cancer (days)	25,550[c]	25,550[c]	25,550[c]	25,550[c]	25,550[c]	25,550[c]	25,550[c]	25,550[c]
Averaging Time, noncancer (days)	2,190[b]	2,190[b]	3,285[b]	10,950[b]	1,533[b]	9,125[b]	site specific	
Exposure time at/near site (hr/day)	24[d]	24[d]	24[d]	24[d]	8[d]	8[d]	8[d]	8[d]
Exposure frequency (d/y)	350[c]	350[c]	350[c]	350[c]	250[c]	250[c]	5[d]	20[d]
Exposure duration, (y)	6[c]	6[c]	9[c]	30[c]	4.2[b]	25[b]	1[d]	1[d]
Soil ingestion (mg/d)	100[c]	200[c]	10	100	10[d]	50[c]	10[d]	50[c]
Inhalation rate (m3/d)	15[a]	20[c]	15[a]	20[c]	15[a]	20[c]	15[a]	20[c]
Soil-Skin Adherence factor (mg/cm2)	NA	NA	NA	NA	0.2[e]	1.0[e]	0.2[e]	1.0[e]
Total skin surface area (cm2)	7,200[b]	7,200[b]	18,150[b]	18,150[b]	18,150[b]	18,150[b]	18,150[b]	18,150[b]
Fraction of skin exposed to soil/sediment	NA	NA	NA	NA	0.125[e]	0.25[e]	0.125[e]	0.25[e]

a calculated.
b EFH, USEPA (1989b).
c RAGS, USEPA (1989a).
d based on professional judgement.
e DEAPA, USEPA (1992a).
NA Not applicable

TABLE 5-4
DERMAL EXPOSURE PARAMETERS
(Page 1 of 2)

Chemical	CAS Number	Molecular Weight	log(Kow)	Kp(a)	ABS(b)
Antimony	7440-36-0	--	--	1.0E-03	1.0E-02
Aroclor-1242	53469-21-9	261	4.11 (c)	4.0E-02 (d)	6.0E-02 (g)
Aroclor-1248	12672-29-6	288	6.11 (c)	7.3E-01 (d)	6.0E-02 (g)
Aroclor-1254	11097-69-1	327	6.3 (c)	5.7E-01 (d)	6.0E-02 (g)
Aroclor-1260	11096-82-5	372	6.11 (c)	2.2E-01 (d)	6.0E-02 (g)
Arsenic	7440-38-2	--	--	1.0E-03	1.0E-02
Benzene	71-43-2	--	--	1.1E-01	2.5E-01
Benzo(a)pyrene	50-32-8	--	--	1.2E+00	1.0E-01
Benzo(b)fluoranthene	205-99-2	252	6.124 (c)	1.1E+00 (d)	1.0E-01
Beryllium	7440-41-7	--	--	1.0E-03	1.0E-02
Bis(2-ethylhexyl)phthalate	117-81-7	--	--	3.3E-02	1.0E-01
Cadmium (food,soil)	7440-43-9	--	--	NA	1.0E-02 (g)
Cadmium (water)	7440-43-9	--	--	1.0E-03	NA
Calcium	7440-70-2	--	--	1.0E-03	1.0E-02
Carbon disulfide	75-15-0	--	--	5.0E-01	2.5E-01
Chloromethane	74-87-3	--	--	4.2E-03	2.5E-01
Chromium (III)	16065-83-1	--	--	1.0E-03	1.0E-02
Chromium (VI)	7440-47-3	--	--	1.0E-03	1.0E-02
Copper	7440-50-8	--	--	1.0E-03	1.0E-02
Cyanide	57-12-5	--	--	1.0E-03	1.0E-02
Dibenzofuran	132-64-9	168	4.12 (h)	1.5E-01 (d)	1.0E-01
Dichloroethane, 1,2-	107-06-2	--	--	5.3E-03	2.5E-01
Dichloroethene, 1,1-	75-35-4	--	--	1.6E-02	2.5E-01
Dichloroethene, 1,2- (mixed isomers)	540-59-0	97	1.86 (f)	1.0E-02 (d)	2.5E-01
Dichloroethene-cis, 1,2-	156-59-2	97	1.86 (f)	1.0E-02 (d)	2.5E-01
Dichloroethene-trans, 1,2-	156-60-5	97	2.06 (f)	1.4E-02 (d)	2.5E-01
Ethylbenzene	100-41-4	--	--	1.0E+00	2.5E-01
Fluorene	86-73-7	116	4.2 (e)	3.6E-01 (d)	1.0E-01
Iron	7439-89-6	--	--	1.0E-03	1.0E-02
Lead	7439-92-1	--	--	1.0E-03	1.0E-02
Manganese (soil)	7439-96-5	--	--	NA	1.0E-02
Manganese (water)	7439-96-5	--	--	1.0E-03	NA
Mercury, elemental	7439-97-6	--	--	1.0E-03	1.0E-02
Mercury, inorganic	7439-97-6	--	--	1.0E-03	1.0E-02
Methylene chloride	75-09-2	--	--	4.5E-03	2.5E-01
Methylnaphthalene, 2-	91-57-6	142	3.86 (c)	1.4E-01 (d)	1.0E-01
Nickel	7440-02-0	--	--	1.0E-03	1.0E-02
Sodium	7440-23-5	--	--	1.0E-03	1.0E-02
Tetrachloroethene	127-18-4	--	--	3.7E-01	2.5E-01
Toluene	108-88-3	--	--	1.0E+00	2.5E-01
Trichloroethane, 1,1,1-	71-55-6	--	--	1.7E-02	2.5E-01
Trichloroethene	79-01-6	--	--	2.3E-01	2.5E-01
Vinyl chloride	75-01-4	--	--	7.3E-03	2.5E-01
Xylenes	1330-20-7	106	3.26 (i)	8.9E-02 (d)	2.5E-01
Zinc	7440-66-6	--	--	1.0E-03	1.0E-02

(a) Kp values obtained from the Dermal Exposure Assessment Principles and Applications (USEPA, 1992a), unless otherwise not

(b) ABS values of 0.25, 0.1, and 0.01 were assumed for volatile, semivolatile, and inorganic compounds, respectively (Ryan *et al.*, 1986), unless otherwise noted.

(c) Source: HSDB (1995).

(d) Kp values calculated using the formula: $\log(Kp) = -2.72+0.71*\log(Kow)-0.0061*MW$ (USEPA, 1992a).

(e) Source: ATSDR (1993a).

(f) Source: Howard *et al.* (1990-1993) Fate and Exposure Data for Organic Chemicals, Volumes I-IV.

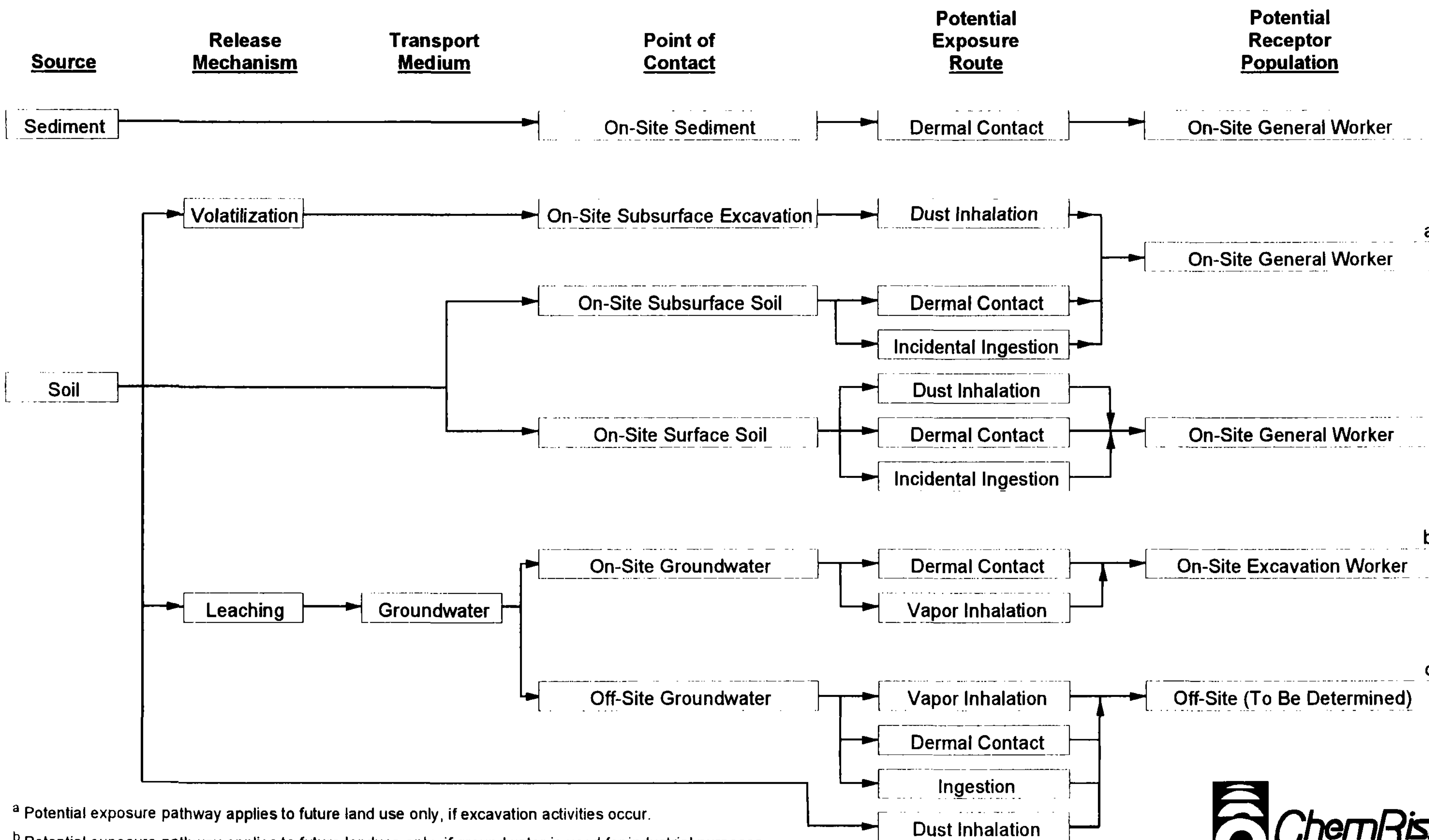
(g) ABS value obtained from USEPA (1992a).

(h) Source: Montgomery and Welkom (1991), Groundwater Chemical Desk Reference.

(i) Data not available. Evaluated using the K_p for benzene.

NA = not applicable.

Figure 5-1
Preliminary Conceptual Exposure Model for GE Aircraft Engines, Evendale, Ohio



[a] Potential exposure pathway applies to future land use only, if excavation activities occur.

[b] Potential exposure pathway applies to future landuse only, if groundwater is used for industrial purposes

[c] Potential exposure is dependent on results of fate & transport modeling of potential off-site migration of chemicals in groundwater.

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6.0 TOXICITY ASSESSMENT

This section presents the chemical specific dose-response information to be used in the risk assessment. Chemical/physical property information necessary for fate and transport modeling is also presented.

6.1 Dose-Response Information Sources

Toxicity values used for risk assessment were obtained according to the following hierarchy of sources:

(1) *Integrated Risk Information System (IRIS)* - IRIS is an on-line data-base which provides toxicity values for chronic oral and inhalation exposures. All data contained in IRIS is verified by a USEPA work group and is updated monthly. As such, IRIS serves as the primary source of toxicity values for the risk assessment.

(2) *Health Effects Assessment Summary Tables (HEAST)* -HEAST is a USEPA document which supplements IRIS by providing nonverified toxicity values, as well as values for evaluating the potential for noncancer effects following subchronic exposures. Information in HEAST is updated quarterly and is used as a secondary source when information is not available from IRIS.

(3) *Provisional Values* - In the absence of established values from IRIS or HEAST, provisional toxicity values are used and are available from several sources (*i.e.* ECAO's Superfund Technical Support Center, ATSDR Toxicological Profiles, USEPA Regional Toxicologists) .

(4) *Surrogate Values* - When toxicity values for a chemical are not available from the sources listed above, the use of a surrogate value may be necessary. This process involves applying a toxicity value established for one chemical to another chemical for which no value has been established. The application of surrogate values is based on similarities in structure, mechanism of action, and toxicity.

(5) *Values Derived by ChemRisk®* - These include toxicity values for several essential nutrients (*e.g.*, calcium, chloride, iron, magnesium, potassium, and sodium) based on the daily intakes considered to be essential for human health. The general approach for deriving these provisional RfDs is described in Appendix B.

6.2 Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with exposure to COIs will be evaluated using acceptable daily intake levels (*i.e.*, reference doses and concentrations) established by the USEPA (IRIS, 1996; HEAST, 1995) or as described above. It is widely accepted that most biological effects of chemicals occur only after a threshold dose is exceeded (Klaassen *et al.*, 1986; Paustenbach, 1989a). For the purposes of establishing noncarcinogenic health criteria, this threshold dose is usually estimated from the no-observed adverse effect level (NOAEL) or lowest-observed adverse effect level (LOAEL) determined in animal or human studies. The NOAEL is defined as the exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects (USEPA, 1989a). The LOAEL is the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects (USEPA, 1989a). The LOAEL or NOAEL from the most sensitive animal or human study is used by the USEPA to establish long-term health criteria, termed reference doses (RfDs). An RfD is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of the <u>dose</u> of a chemical (expressed in mg/kg-day) which is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1989a). Similarly, a reference concentration (RfC) represents the <u>concentration</u> of a chemical in environmental media (expressed in μg/L for water or mg/m^3 for air) which is likely to be without an appreciable risk of deleterious effects during a life time (USEPA, 1989a). When deriving an RfD or RfC, a NOAEL value is used preferentially over a LOAEL value if both are available from the key study. The USEPA derives RfDs and RfCs by applying uncertainty factors to the NOAEL or LOAEL value to provide a margin of safety. The equation for deriving an RfD or RfC is shown below:

$$RfD \text{ or } RfC = (NOAEL \text{ or } LOAEL) / (UF \times MF)$$

where:

RfD	= reference dose (mg/kg/day);
RfC	= reference concentration (mg/m^3);
NOAEL	= no-observed-adverse-effect-level;
LOAEL	= lowest-observed-adverse-effect-level;
UF	= uncertainty factor; and
MF	= modifying factor.

Uncertainty factors can range from 1 to 10,000 and may include a factor of up to 10 to account for each of the following:

- variation in sensitivity within human populations;
- extrapolation of effects observed in animals to humans;
- extrapolation from less-than-lifetime exposures in the critical study to lifetime exposures; and
- extrapolation from a LOAEL to a NOAEL, if necessary.

In some cases, a modifying factor (usually ranging from 1 to 10) is also applied to the NOAEL/LOAEL. This value reflects a qualitative professional assessment of additional uncertainties in the critical study and in the entire database for the chemical not explicitly addressed by the above uncertainty factors (USEPA, 1989a). Reference doses and concentrations can be interconverted using default exposure assumptions (*i.e.*, 70 kg body weight, 2 L/day water intake, 20 m^3/day breathing rate). The USEPA establishes RfDs and RfCs for evaluating both subchronic (less than 7 years) and chronic (7 years or more) exposures. Values for both durations are identified here for use in the risk assessment.

Although USEPA has not established noncarcinogenic toxicity values for dermal exposure, dermal values (*i.e.*, dermal reference doses) can be derived from oral RfDs to quantify risks associated with dermal exposure to chemicals in water and soil. A fundamental difference must be recognized, however, when deriving dermal toxicity values from oral toxicity values: oral and inhalation RfDs are generally expressed in terms of an administered dose, whereas the calculated dermal RfDs are expressed in terms of an absorbed dose. Dermal exposure is assessed by estimating the absorbed dermal dose. Because dermal exposure is assessed in terms of absorbed dose, the dermal toxicity values must also be expressed in terms of an absorbed dose. This is accomplished by multiplying the oral RfDs by available oral absorption fractions (Owen, 1990; HEAST, 1995). In the absence of data, an oral absorption fraction of 1 is assumed (*i.e.*, 100% of the chemical is absorbed). It should be recognized that dermal RfDs are intended to be protective for systemic effects that may occur following dermal exposure, and may not necessarily be protective for effects occurring at the point of contact (*i.e.*, dermal sensitization, irritation).

Subchronic and chronic oral RfDs and the USEPA's confidence level in the chronic value are presented in Table 6-1 for chemicals identified as PCOIs. In addition, the test species, critical effect, exposure media used in the key study, and source of the RfD are identified. Some chemicals have more than one entry in the table; specifically, two RfDs have been developed by USEPA for cadmium (in food and water), chromium (trivalent and hexavalent), manganese (in food and water), and mercury (elemental and inorganic). The majority of the chemicals (50%) have RfDs available from IRIS (1996) or HEAST (1995); however, a number of chemicals are represented by provisional RfDs or surrogate RfDs. Surrogate RfDs were developed assuming equal potency between the chemical and the surrogate chemical. RfDs were not identified for 2-hexanone and lead.

Although the USEPA has not derived an RfD for lead, lead will be evaluated separately at the site using the Integrated Exposure Uptake/Biokinetic (IEUBK) Model (USEPA, 1994) for exposure scenarios involving children (6 months to 7 years of age) or by a physiologically-based pharmacokinetic (PBPK) model for exposure scenarios involving youths and adults (O'Flaherty, 1993). The IEUBK model is typically utilized by USEPA to evaluate the risks associated with residential child exposures to lead. The greater flexibility of the PBPK model in defining exposure populations makes it useful for evaluating occupational exposures (*i.e.*, adult exposures) to lead at the facility and will be used for this purpose in the planned risk assessments.

Subchronic and chronic inhalation RfCs and RfDs and the USEPA's confidence in the chronic value are shown in Table 6-2. The test species, critical effect from the key study, and the source of the RfC/RfD are identified. Only a small fraction of the chemicals have RfCs/RfDs available from IRIS (1996) or HEAST (1995). A few chemicals (10) are represented by provisional values from other sources (ATSDR 1993a,b,c; USEPA, 1995c,d,e). Chemicals lacking toxicity values are not shown in this table. For these chemicals, the oral RfD will be used to evaluate inhalation hazards in the quantitative risk assessment.

Inhalation RfDs were calculated from the corresponding RfC values using the following equation:

$$Inhalation\ RfD = (Inhalation\ RfC) \times (Breathing\ Rate) / (Body\ Weight)$$

where:

Inhalation RfC	= chemical-specific inhalation reference concentration in mg/m^3;
Breathing Rate	= 20 m^3/day, default value for an adult; and
Body Weight	= 70 kg, default value for an adult.

The USEPA generally reports only RfC values in IRIS and HEAST because the Agency feels it is technically more accurate to base toxicity values directly on measured air concentrations than to make an estimate of the administered dose. Uncertainties associated with this type of conversion include those surrounding deposition and absorption of the chemical in the lung, both of which are dependent upon physico-chemical properties of the chemical, the phase of the chemical in air (*i.e.*, vapor, particulate, aerosol), and characteristics of the exposed species. The USEPA recognizes the need for expressing toxicity values in terms of a dose (mg/kg-day) for risk assessment purposes, and acknowledges that in many cases the conversion of an RfC to a dose does not add significant uncertainty to the risk assessment process (HEAST, 1995). In addition, the appropriateness of this conversion is dependent on the toxicological endpoint observed in the key study. For example, it may be inappropriate to estimate an internal dose for compounds that act at the point of contact (*i.e.*, sensitizers and irritants of the upper respiratory tract). In these cases the toxicological endpoint is dependent only upon the concentration of the chemical in air and not upon the chemical dose expressed on a per body weight basis. For example, a chemical irritant will irritate nasal passages and lungs at a given concentration regardless of whether the exposed individual weighs 15 kg or 70 kg. In addition, this conversion might inappropriately imply effects to other organ systems or effects from other exposure routes.

Subchronic and chronic dermal RfDs were derived from oral RfDs using the following equation:

$$Dermal\ RfD = (Oral\ RfD) \times (Afo)$$

where:

Oral RfD	=	chemical-specific oral reference dose in mg/kg/day (Table 6-1); and
AFo	=	chemical-specific oral absorption fraction (Table 6-3).

Dermal RfDs derived in this manner are shown in Table 6-3. Dermal RfDs are intended to be protective for any systemic effects that may occur following dermal exposure, and may not necessarily be protective for effects occurring at the point of contact (*i.e.*, dermal sensitization, irritation). Nickel and chromium, for example, are two chemicals which are known to produce dermal sensitization.

Additivity of Noncarcinogenic Effects

Multiple chemical exposures can result in synergism, antagonism and/or additivity of biological responses when the chemicals act on similar target organs or when they are metabolized by the same enzymatic pathways. It is appropriate in risk assessment to evaluate the possible health effects associated with multiple chemical exposures at a site. USEPA risk assessment guidelines (USEPA, 1989a) state that additivity of noncarcinogenic health effects should only be considered if the chemicals have the same toxicological endpoint (*e.g.*, organ or enzyme systems). Additivity for all chemicals will initially be assumed to occur regardless of the toxicological endpoint. This approach is likely to overestimate the true human health risks associated with exposure to the COIs since many chemicals may act on different target organs (*i.e.*, lung, liver, kidneys). If the target hazard index is exceeded, a segregation of the hazard index by toxicological endpoint will be considered.

6.3 Carcinogenic Health Effects

Health risks from exposures to carcinogens are defined in terms of probabilities. These probabilities identify the likelihood of a carcinogenic response in an individual that receives a given dose of a particular compound. The slope factor (SF), expressed in units of $(mg/kg\text{-}day)^{-1}$, multiplied by the lifetime average daily dose of the chemical, provides an estimate of the theoretical excess cancer risk. Slope factors represent an upper-bound estimate of the probability of developing cancer per unit dose (expressed as risk per mg/kg-day) of a chemical over time (USEPA, 1989a). Similarly, unit risks (URs) represent an upper-bound estimate of the probability of developing cancer per unit concentration [expressed as risk per $(\mu g/L)^{-1}$ for water; risk per $(\mu g/m^3)^{-1}$ for air] of a chemical over time. Slope factor and UR values can also be interconverted using default exposure assumptions (*i.e.*, 70 kg body weight, 2 L/day water intake, 20 m^3/day breathing rate).

USEPA derives SFs for oral and inhalation exposure pathways but not for dermal exposure. However, dermal SFs can be calculated by adjusting oral SFs from an administered to absorbed dose (USEPA, 1989a). To account for the difference in administered dose versus absorbed dose the oral slope factor is divided by available oral absorption fractions. It should be recognized that there are certain instances when it is not appropriate to derive dermal slope factors from oral values. For example, carcinogenic PAHs act at the point of contact to produce tumors in the upper digestive tract following oral exposure but would not be expected to produce these tumors following dermal exposure. Since it would be inappropriate to derive a dermal slope factor based on the same study used to derive the oral slope factor, dermal slope factors have not been derived for carcinogenic PAHs.

The cancer weight-of-evidence classification is a qualitative descriptor that characterizes the quality and quantity of the data concerning the potential carcinogenicity of the chemicals. As defined by the USEPA (1989a), there are six weight-of-evidence groups to which a chemical may be assigned:

Group A Human Carcinogen (sufficient evidence of carcinogenicity in humans),

Group B1 Probable Human Carcinogen (limited evidence of carcinogenicity in humans),

Group B2 Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans),

Group C Possible Human Carcinogen (limited evidence of carcinogenicity in animals or lack of human data),

Group D Not Classifiable as to Human Carcinogenicity (inadequate or no evidence), and

Group E Evidence of Non-Carcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

Consistent with USEPA guidelines (USEPA, 1989a), chemicals assigned a weight-of-evidence classification of A, B1, or B2 will be quantitatively evaluated for carcinogenic dose-response. All Group C carcinogens will also be quantitatively evaluated for carcinogenic effects.

Oral URs and SFs, and the USEPA's cancer weight-of-evidence classification are shown in Table 6-4. In addition, the test species, tumor site/type, and exposure media from the key study are identified. Noncarcinogens are not presented in this table. A majority of the carcinogens (>50%) have URs/SFs available from IRIS (1996) or HEAST (1995); however, a few chemicals are presented by provisional or surrogate values (USEPA, 1995d,e,f) (Table 6-6). Extrapolations of the SFs for PAHs were made using a relative potency approach (USEPA, 1993). Although cadmium and chromium (VI) have cancer weight-of-evidence classifications higher than C, these metals are only considered carcinogenic by the inhalation route. Oral SFs are not available for 3 chemicals (1,1-dichloroethane, lead, mercury). Provisional SFs may be developed for these chemicals as discussed above or they may be addressed qualitatively in the planned risk assessments.

In some cases, an oral SF was calculated from the corresponding UR using the following equation:

Oral SF = (Oral UR) x (Body Weight) x (Conversion Factor) / (Water Intake)

where:

Oral UR	=	chemical-specific oral unit risk in $(\mu g/L)^{-1}$;
Body Weight	=	70 kg, default value for an adult;
Conversion Factor	=	1,000 μg/mg; and
Water Intake	=	2 L/day, default intake for an adult.

The oral UR was multiplied by terms for body weight and a unit conversion factor and divided by the intake rate term. Expression of the UR in terms of a dose is necessary to evaluate cancer risk associate with exposure media other than drinking water (*i.e.*, soil, sediment). The USEPA recognizes the need for expressing toxicity values in terms of a dose (mg/kg-day) for risk assessment purposes, and acknowledges that in many cases this conversion does not add significant uncertainty to the risk assessment process (HEAST, 1995).

Inhalation URs and SFs, and the USEPA's cancer weight-of-evidence classification are shown in Table 6-5. In addition, the test species, tumor site/type, exposure media, and the source of the UR/SF are identified. Noncarcinogens are not presented in this table. Only a fraction of the carcinogenic PCOIs have URs/SFs available from IRIS (1996) or HEAST (1995). A number of PCOIs are represented with provisional values either from other sources or are based on route-to-route (oral-to-inhalation) extrapolation. Provisional values are noted as such in Table 6-5. Although nickel (in the form of refinery dust) and chromium (in its hexavalent form) are considered carcinogens by the inhalation, these specific forms of the metals are not expected to occur at the site based upon historical use information. Inhalation SFs are not available for 3 potentially carcinogenic chemicals (1,1-dichloroethane, lead, mercury). For these chemicals, the oral SF will be used to evaluate risk from inhalation exposures. Alternatively, provisional SFs may be developed for these chemicals as discussed previously or they may be addressed qualitatively in the risk assessment.

In some cases, an inhalation SF was calculated from the corresponding UR using the following equation:

$$\textit{Inhalation SF} = \frac{\textit{(Inhalation UR) x (Body Weight) x (Conversion Factor)}}{\textit{(Breathing Rate)}}$$

where:

Inhalation UR	=	chemical-specific inhalation unit risk in $(\mu g/m^3)^{-1}$;
Body Weight	=	70 kg, default for an adult;
Conversion Factor	=	1000 μg/mg; and
Breathing Rate	=	20 m^3/day, default value for an adult.

As noted above for inhalation RfC-to-RfD conversions (see Section 6.2), the conversion of an inhalation UR to and SF probably does not add significant uncertainty to the risk assessment process (HEAST, 1995). However, there may be some cases where this conversion is inappropriate.

Dermal SFs which were derived from oral SFs using the following equation:

$$\textit{Dermal SF} = \textit{(Oral SF) / (AFo)}$$

where:

Oral SF	=	chemical-specific oral slope factor in $(mg/kg/day)^{-1}$ (Table 6-4); and
AFo	=	chemical-specific oral absorption fraction (Table 6-6).

Dermal SFs derived in this manner are shown in Table 6-6. There are certain instances when it is not appropriate to extrapolate dermal SFs from oral values. For example, chemicals which act at the point of contact by producing tumors in the upper digestive tract following oral exposure (*i.e.*, carcinogenic PAHs), are more likely to produce skin tumors following dermal exposure. Dermal SFs derived in this manner do not consider skin tumor development, and therefore are not derived for PAHs in this report. For this reason, potential cancer risk from dermal exposure to PAHs can only be addressed qualitatively. The absence of dermal SFs for PAHs and other point-of-contact acting chemicals will be addressed in discussions of uncertainty in the risk assessment (USEPA, 1989a).

6.4 Physical/Chemical Properties

The purpose of this section is to summarize the key physical/chemical properties related to environmental fate and transport processes for identified COIs. This information is used to identify complete exposure pathways under current and future conditions as described in Section 4.3.

Chemicals introduced into the environment may adsorb to soils, leach from soil into migrating water, or volatilize from soil into the atmosphere. In addition, a chemical may undergo photo- or microbial degradation to other products (Paustenbach, 1989b). The physico-chemical characteristics of a compound play a major role in its environmental fate and transport behavior and govern, to a large extent, the ability of a chemical to move from one matrix to another.

The primary physico-chemical and environmental fate parameters used to qualitatively characterize the fate and transport of COIs in soil and groundwater are (1) molecular weight, (2) vapor pressure and Henry's Law Constant, (3) water solubility, (4) organic carbon partitioning coefficient (K_{oc}), and (5) degradation half-life. Vapor pressure and Henry's Law Constant are used to evaluate the potential for COIs to volatilize from soil and/or water into ambient air. Water solubility and K_{oc} are used to evaluate the potential for COIs to migrate in soils and groundwater. The persistence of COIs, or environmental fate, may be characterized using soil and groundwater degradation half-lives. Physico-chemical parameters are provided in Tables 6-7 and 6-8 for the PCOIs.

TABLE 6-1
ORAL REFERENCE DOSES
(Page 1 of 2)

Chemical	CAS Number	Test Species	Method of Administration	Critical Effect(s)	Subchronic RfD (mg/kg-d)	Subchronic Source[a]	Chronic RfD (mg/kg-d)	Chronic Source[a]	Confidence
Antimony	7440-36-0	Rat	Water	Increased mortality, altered chemistries	0.0004	HEAST	0.0004	IRIS	Low
Aroclor-1242	53469-21-9	Monkey	Food	Effects judged to be similar to Aroclor-1016	0.00007	CHR	0.00007	IRIS	Medium
Aroclor-1248	12672-29-6	Monkey	Capsule	Effects judged to be similar to Aroclor-1254	0.00005	SUR	0.00002	SUR	
Aroclor-1254	11097-69-1	Monkey	Capsule	Ocular effects, inflamed meibomian glands, distorted nail growth, decreased antibody response	0.00005	HEAST	0.00002	IRIS	Medium
Aroclor-1260	11096-82-5	Monkey	Capsule	Effects judged to be similar to Aroclor-1254	0.00005	SUR	0.00002	SUR	
Arsenic	7440-38-2	Human	Water, Food	Keratosis, hyperpigmentation	0.0003	HEAST	0.0003	IRIS	Medium
Benzene	71-43-2	Rat	Gavage	Slight Leukemia	0.0003	CHR	0.0003	ECAO	Low
Benzo(a)pyrene	50-32-8	Mouse	Gavage	Effects judged to be similar to pyrene	0.3	SUR	0.03	SUR	
Benzo(b)fluoranthene	205-99-2	Mouse	Gavage	Effects judged to be similar to pyrene	0.3	SUR	0.03	SUR	
Beryllium	7440-41-7	Rat	Water	None observed	0.005	HEAST	0.005	IRIS	Low
Bis(2-ethylhexyl)phthalate	117-81-7	Guinea pig	Food	Increased liver weight	0.02	CHR	0.02	IRIS	Medium
Cadmium (food,soil)	7440-43-9	Human	Food	Significant proteinuria	0.001	CHR	0.001	IRIS	High
Cadmium (water)	7440-43-9	Human	Water	Significant proteinuria	0.0005	CHR	0.0005	IRIS	High
Calcium	7440-70-2			None observed	100	RDA	20	RDA	
Carbon disulfide	75-15-0	Rat		Fetal toxicity	0.1	HEAST	0.1	IRIS	Medium
Chloromethane	74-87-3	Human	Inhalation	Neurological	0.004	CHR	0.004	ECAO	Low
Chromium (III)	16065-83-1	Rat	Food	None observed	1	HEAST	1	IRIS	Low
Copper	7440-50-8	Human	Water	Gastro-Intestinal effects	0.07	CHR	0.07	ECAO	
Cyanide	57-12-5	Rat	Food	Decreased body weight, thyroid effects, myelin degeneration	0.02	HEAST	0.02	IRIS	Medium
Dibenzofuran	132-64-9	Rat	Food	Kidney effects	0.004	CHR	0.004	ECAO	Low
Dichloroethane, 1,1-	75-34-3	Rat		None observed	0.1	CHR	0.1	HEAST	
Dichloroethane, 1,2-	107-06-2	Rat	Gavage	General toxicity	0.03	CHR	0.03	ECAO	
Dichloroethene, 1,1-	75-35-4	Rat	Water	Liver lesions	0.009	HEAST	0.009	IRIS	Medium
Dichloroethene, 1,2- (mixed isomers)	540-59-0	Rat	Water	Liver lesions	0.009	HEAST	0.009	HEAST	
Dichloroethene-cis, 1,2-	156-59-2	Rat	Gavage	Hematological changes	0.1	HEAST	0.01	HEAST	
Dichloroethene-trans, 1,2-	156-60-5	Mouse	Water	Hematological changes	0.2	HEAST	0.02	IRIS	Low
Ethylbenzene	100-41-4	Rat	Gavage	Developmental toxicity	0.1	CHR	0.1	IRIS	Low
Fluorene	86-73-7	Mouse	Gavage	Decreased red blood cell count	0.4	HEAST	0.04	IRIS	Low
Lead	7439-92-1					HEAST		IRIS	
Manganese (food)	7439-96-5	Human	Food	Central nervous system effects	0.14	HEAST	0.14	IRIS	
Manganese (soil, water)	7439-96-5	Human	Water	Central nervous system effects	0.047	CHR	0.047	IRIS	
Mercury, elemental	7439-97-6			Effects judged to be similar to inorganic mercury	0.0003	SUR	0.0003	SUR	

TABLE 6-1
ORAL REFERENCE DOSES

Chemical	CAS Number	Test Species	Method of Administration	Critical Effect(s)	Subchronic RfD (mg/kg-d)	Subchronic Source[a]	Chronic RfD (mg/kg-d)	Chronic Source[a]	Confidence
Mercury, elemental	7439-97-6			Effects judged to be similar to inorganic mercury	0.0003	SUR	0.0003	SUR	
Mercury, inorganic	7439-97-6	Rat		Kidney effects	0.0003	HEAST	0.0003	IRIS	High
Methylene chloride	75-09-2	Rat	Water	Liver toxicity	0.06	HEAST	0.06	IRIS	Medium
Methylnaphthalene, 2-	91-57-6			Effects judged similar to naphthalene	0.04	SUR	0.04	SUR	
N-nitrosodiphenylamine	86-30-6	Rat	Food	Decreased body weight	0.02	CHR	0.02	ECAO	Low
Naphthalene	91-20-3	Rat	Gavage	Decreased body weight	0.04	CHR	0.04	ECAO	
Nickel	7440-02-0	Rat	Food	Decreased organ and body weight	0.02	HEAST	0.02	IRIS	Medium
Phenanthrene	85-01-8	Mouse	Gavage	Effects judged similar to pyrene	0.3	SUR	0.03	SUR	
Tetrachloroethane, 1,1,2,2-	79-34-5	Rat	Gavage	Body weight decreased; Renal effects	0.3	CHR	0.3	MRL (ATSDR, 1994)	
Tetrachloroethene	127-18-4	Mouse	Gavage	Liver toxicity	0.1	HEAST	0.01	IRIS	Medium
Toluene	108-88-3	Rat	Gavage	Altered liver and kidney weight	2	HEAST	0.2	IRIS	Medium
Trichloroethane, 1,1,1-	71-55-6			Liver toxicity	0.09	CHR	0.09	PRG, W	
Trichloroethane, 1,1,2-	79-00-5	Mouse	Water	Hematological effects	0.04	HEAST	0.004	IRIS	Medium
Trichloroethene	79-01-6	Mouse	Water	Liver and kidney effects	0.006	CHR	0.006	ECAO	Low
Vinyl acetate	108-05-4								
Vinyl chloride	75-01-4	Rat	Food		0.00002	CHR	0.00002	MRL (ATSDR, 1993b)	
Xylenes	1330-20-7	Rat	Gavage	Decreased body weight, increased mortality, hyperactivity	2	CHR	2	IRIS	Medium
Zinc	7440-66-6	Human	Supplements	Hematological effects	0.3	HEAST	0.3	IRIS	Medium

a Codes used:

CHR	Chronic RfD used for subchronic RfD.
ECAO	Value issued by the Environmental Criteria and Assessment Ofice of the Superfund Technical Support Center (ECAO, 1995).
HEAST	Value from HEAST Table 1 (HEAST, 1995).
IRIS	Value from IRIS database (IRIS, 1996).
MRL	The intermediate minimal risk level (MRL) was used as a surrogate value; source in parentheses.
PRG	Provisional value from USEPA Region IX (PRG, 1996).
RDA	Evaluated using the RDA/EMR/ESADDI (NAS, 1989) for a child (for subchronic RfD) and an adult (for chronic RfD), divided by body weights of 15 and 70 kg, respectively, and multiplied by an uncertainty factor of 2 (see Appendix C).
SUR	Surrogate value used.
W	Value withdrawn from IRIS or HEAST.

T.__ _E 6-2
INHALATION REFERENCE CONCENTRATIONS AND REFERENCE DOSES

				Subchronic				Chronic				
Chemical	CAS Number	Test Species	Critical Effect(s)	RfC (mg/m^3)	Source[a]	RfD (mg/kg-d)	Source[a]	RfC (mg/m^3)	Source[a]	RfD (mg/kg-d)	Source[a]	Confidence
Antimony	7440-36-0		Effects judged to be similar to antimony trioxide	0.0002	SUR	0.000057	SUR	0.0002	SUR	0.000057	SUR	
Antimony trioxide	1309-64-4	Rat	Pulmonary toxicity, chronic interstitial inflamation	0.0002	CHR	0.000057	CHR	0.0002	IRIS	0.000057	CALC	Medium
Benzene	71-43-2			0.006	CHR	0.0017	CHR	0.006	ECAO	0.0017	ECAO	Low
Carbon disulfide	75-15-0	Human	Peripheral nervous system dysfunction	0.7	CHR	0.2	CHR	0.7	IRIS	0.2	CALC	Medium
Chromium (III)	16065-83-1	Human	None observed	0.09	CHR	0.026	CALC	0.09	PROV (Finley et al, 1992)	0.026	CALC	
Chromium (VI)	7440-47-3	Human	None observed	0.00034	CHR	0.0001	CALC	0.00034	PROV (Finley et al, 1992)	0.0001	CALC	
Dichloroethane, 1,1-	75-34-3	Cat	Kidney damage	5	HEAST-2	1.4	CALC	0.5	HEAST-2	0.14	CALC	
Dichloroethane, 1,2-	107-06-2	Human	Liver, Gastro-Intestinal, Gall bladder	0.005	ECAO	0.0014	CALC	0.005	ECAO	0.0014	CALC	Low
Ethylbenzene	100-41-4	Rat, Rabbit	Developmental toxicity	1	HEAST-1, W	0.29	CALC	1	IRIS	0.29	CALC	Low
Manganese (food, soil)	7439-96-5	Human	Respiratory effects, psychomotor disturbances	0.00005	CHR	0.000014	CALC	0.00005	IRIS	0.000014	CALC	Medium
Mercury, elemental	7439-97-6	Human	Neurotoxicity	0.0003	HEAST-1	0.000086	CALC	0.0003	IRIS	0.000086	CALC	Medium
Mercury, inorganic	7439-97-6		Effects judged to be similar to elemental mercury	0.0003	SUR	0.000086	SUR	0.0003	SUR	0.000086	SUR	
Methylene chloride	75-09-2	Rat	Liver toxicity	3	HEAST-1	0.86	CALC	3	HEAST-1	0.86	CALC	
Tetrachloroethene	127-18-4	Mouse	Hepatic and Renal effects	0.4	CHR	0.11	CALC	0.4	ECAO	0.11	CALC	Medium
Toluene	108-88-3	Human, Rat	Neurological effects, eye and nose irritation	0.4	CHR	0.11	CALC	0.4	IRIS	0.11	CALC	Medium
Trichloroethane, 1,1,1-	71-55-6		Liver toxicity	10	HEAST-2, W	2.9	CALC			0.29	PRG	
Trichloroethene	79-01-6	Rat	Neurological effects			3.1	CHR			3.1	PROV (ATSDR, 1995)	
Vinyl acetate	108-05-4	Rat, mouse	Nasal epithelial lesions					0.2	IRIS	0.057	CALC	High
Vinyl chloride	75-01-4	Rat	Increased liver weight			0.0015	CHR			0.0015	PROV (ATSDR, 1993b)	
Xylenes	1330-20-7					0.086	CHR			0.086	PRG, W	

TA___ 6-2
INHALATION REFERENCE CONCENTRATIONS AND REFERENCE DOSES
(Page 2 of 2)

a Codes used:

CALC	RfD calculated from the corresponding RfC value assuming a breathing rate of 20 m^3/day for a 70 kg adult.
CHR	Chronic RfD used for subchronic RfD.
ECAO	Value issued by the Environmental Criteria and Assessment Ofice of the Superfund Technical Support Center (ECAO, 1995).
HEAST-1	Value from HEAST Table 1 (HEAST, 1995).
HEAST-2	Value from HEAST Table 2 (HEAST, 1995).
IRIS	Value from IRIS database (IRIS, 1996).
PRG	Provisional value from USEPA Region IX (PRG, 1996).
PROV	Provisional value; source in parentheses.
SUR	Surrogate value used; surrogate chemical in parentheses.
W	Value withdrawn from IRIS or HEAST.

TABLE 6-3
DERMAL REFERENCE DOSES
(Page 1 of 2)

Chemical	CAS Number	Subchronic RfD (mg/kg-day)(a)	Chronic Oral RfD (mg/kg-day)(a)	Oral Absorption Fraction(b)	Subchronic Dermal RfD (mg/kg-day)	Chronic Dermal RfD (mg/kg-day)
Antimony	7440-36-0	0.0004	0.0004	0.1 (c)	0.00004	0.00004
Aroclor-1242	53469-21-9	0.00007	0.00007	0.95 (d)	0.0000665	0.0000665
Aroclor-1248	12672-29-6	0.00005	0.00002	0.95 (d)	0.0000475	0.000019
Aroclor-1254	11097-69-1	0.00005	0.00002	0.95 (d)	0.0000475	0.000019
Aroclor-1260	11096-82-5	0.00005	0.00002	0.95 (d)	0.0000475	0.000019
Arsenic	7440-38-2	0.0003	0.0003	0.98 (d)	0.000294	0.000294
Benzene	71-43-2	0.0003	0.0003	1 (d)	0.0003	0.0003
Benzo(a)pyrene	50-32-8	0.3	0.03	1	0.3	0.03
Benzo(b)fluoranthene	205-99-2	0.3	0.03	1	0.3	0.03
Beryllium	7440-41-7	0.005	0.005	0.005 (c)	0.000025	0.000025
Bis(2-ethylhexyl)phthalate	117-81-7	0.02	0.02	1	0.02	0.02
Cadmium (food,soil)	7440-43-9	0.001	0.001	0.025 (e)	0.000025	0.000025
Cadmium (water)	7440-43-9	0.0005	0.0005	0.05 (e)	0.000025	0.000025
Calcium	7440-70-2	100	20	0.3 (c)	30	6
Carbon disulfide	75-15-0	0.1	0.1	1	0.1	0.1
Chloromethane	74-87-3	0.004	0.004	1	0.004	0.004
Chromium (III)	16065-83-1	1	1	0.01 (d)	0.01	0.01
Copper	7440-50-8	0.07	0.07	0.5 (c)	0.035	0.035
Cyanide	57-12-5	0.02	0.02	1	0.02	0.02
Dibenzofuran	132-64-9	0.004	0.004	1	0.004	0.004
Dichloroethane, 1,1-	75-34-3	0.1	0.1	1	0.1	0.1
Dichloroethane, 1,2-	107-06-2	0.03	0.03	1	0.03	0.03
Dichloroethene, 1,1-	75-35-4	0.009	0.009	0.93 (d)	0.00837	0.00837
Dichloroethene, 1,2- (mixed isomers)	540-59-0	0.009	0.009	1	0.009	0.009
Dichloroethene-cis, 1,2-	156-59-2	0.1	0.01	1	0.1	0.01
Dichloroethene-trans, 1,2-	156-60-5	0.2	0.02	1	0.2	0.02
Ethylbenzene	100-41-4	0.1	0.1	0.82 (d)	0.082	0.082
Fluorene	86-73-7	0.4	0.04	1	0.4	0.04
Lead	7439-92-1	--	--	0.2 (c)	--	--
Manganese	7439-96-5	0.047	0.047	0.1 (c)	0.0047	0.0047
Mercury, elemental	7439-97-6	0.0003	0.0003	0.02 (c)	0.000006	0.000006
Mercury, inorganic	7439-97-6	0.0003	0.0003	0.02 (c)	0.000006	0.000006
Methylene chloride	75-09-2	0.06	0.06	1 (d)	0.06	0.06

TABLE 6-3
DERMAL REFERENCE DOSES
(Page 2 of 2)

Chemical	CAS Number	Subchronic RfD (mg/kg-day)(a)	Chronic Oral RfD (mg/kg-day)(a)	Oral Absorption Fraction(b)	Subchronic Dermal RfD (mg/kg-day)	Chronic Dermal RfD (mg/kg-day)
Methylnaphthalene, 2-	91-57-6	0.04	0.04	1	0.04	0.04
N-nitrosodiphenylamine	86-30-6	0.02	0.02	1	0.02	0.02
Naphthalene	91-20-3	0.04	0.04	1 (d)	0.04	0.04
Nickel	7440-02-0	0.02	0.02	0.05 (c)	0.001	0.001
Phenanthrene	85-01-8	0.3	0.03	1	0.3	0.03
Tetrachloroethane, 1,1,2,2-	79-34-5	0.3	0.3	1	0.3	0.3
Tetrachloroethene	127-18-4	0.1	0.01	1	0.1	0.01
Toluene	108-88-3	2	0.2	1 (d)	2	0.2
Trichloroethane, 1,1,1-	71-55-6	0.09	0.09	1	0.09	0.09
Trichloroethane, 1,1,2-	79-00-5	0.04	0.004	1	0.04	0.004
Trichloroethene	79-01-6	0.006	0.006	1	0.006	0.006
Vinyl acetate	108-05-4	1	1	1	1	1
Vinyl chloride	75-01-4	0.00002	0.00002	0.9 (d)	0.000018	0.000018
Xylenes	1330-20-7	2	2	1 (d)	2	2
Zinc	7440-66-6	0.3	0.3	0.5 (c)	0.15	0.15

a See Table 6-1 for source of oral RfDs.
b An oral absorption fraction of 1 is assumed in the absence of data.
c Source = HEAST, Table 4 (HEAST,1995).
d Source = Owen (1990).
e Source = IRIS (IRIS, 1996).
"--" = not available.

TABLE 6-4
ORAL UNIT RISKS AND SLOPE FACTORS
(Page 1 of 1)

Chemical	CAS Number	WOE[a]	Test Species	Method of Administration[b]	Tumor Site/ Critical Effect(s)	Unit Risk $(ug/L)^{-1}$	Source[b]	Slope Factor $(mg/kg\text{-}d)^{-1}$	Source[b]
Aroclor-1242	53469-21-9	B2	Rat	Food	Liver			2	IRIS
Aroclor-1248	12672-29-6	B2	Rat	Food	Liver			2	IRIS
Aroclor-1254	11097-69-1	B2	Rat	Food	Liver			2	IRIS
Aroclor-1260	11096-82-5	B2	Rat	Food	Liver			2	IRIS
Arsenic	7440-38-2	A	Human	Water	Skin and internal	0.00005	IRIS	1.5	IRIS
Benzene	71-43-2	A	Human	RRE	Leukemia	0.00000083	IRIS	0.029	IRIS
Benzo(a)pyrene	50-32-8	B2	Mouse	Food	Stomach	0.00021	IRIS	7.3	IRIS
Benzo(b)fluoranthene	205-99-2	B2	Mouse	Food	Effects judged to be similar to benzo(a)pyrene	0.000021	SUR	0.73	SUR, PF(0.1)
Beryllium	7440-41-7	B2	Rat	Water	Bone	0.00012	IRIS	4.3	IRIS
Bis(2-ethylhexyl)phthalate	117-81-7	B2	Mouse	Food	Liver	0.0000004	IRIS	0.014	IRIS
Cadmium (food,soil)	7440-43-9	B1 (inhalation)							
Chloromethane	74-87-3	C	Mouse	RRE	Kidney	0.00000037	HEAST	0.013	HEAST
Dichloroethane, 1,1-	75-34-3	C			Mammary gland, liver, uterus				
Dichloroethane, 1,2-	107-06-2	B2	Rat	Gavage	Hemangiosarcomas, stomach	0.0000026	IRIS	0.091	IRIS
Dichloroethene, 1,1-	75-35-4	C	Rat	Water	Adrenal gland	0.000017	IRIS	0.6	IRIS
Lead	7439-92-1	B2			Kidney				
Mercury, inorganic	7487-94-9	C	Rat	Water	Forestomach papilloma, thyroid tumors				
Methylene chloride	75-09-2	B2	Mouse	Water, Inhalation	Liver	0.00000021	IRIS	0.0075	IRIS
N-nitrosodiphenylamine	86-30-6	B2	Rat	Water	Bladder	0.00000014	IRIS	0.0049	IRIS
Tetrachloroethane, 1,1,2,2-	79-34-5	C	Mouse	Gavage	Liver	0.0000058	IRIS	0.2	IRIS
Tetrachloroethene	127-18-4	B2/C			Liver	0.0000015	ECAO	0.052	ECAO
Trichloroethane, 1,1,2-	79-00-5	C	Mouse	Gavage	Liver	0.0000016	IRIS	0.057	IRIS
Trichloroethene	79-01-6	B2/C			Liver	0.00000032	ECAO	0.011	ECAO
Vinyl chloride	75-01-4	A	Rat	Food	Lung and liver	0.000054	HEAST	1.9	HEAST

a Weight of evidence (WOE) classification:

- A Human carcinogen.
- B1/B2 Probable human carcinogen.
- BC/C Possible/probable human carcinogen.
- C Possible human carcinogen.

b Codes used:

- ECAO Value issued by the Environmental Criteria and Assessment Ofice of the Superfund Technical Support Center (ECAO, 1995).
- HEAST Value from HEAST Table 3 (HEAST, 1995).
- IRIS Value from IRIS database (IRIS, 1996).
- PF Relative potency factor (USEPA, 1993); value in parentheses.
- RRE Route-to-route extrapolation by USEPA, based on inhalation data.
- SUR Surrogate value used.

TABLE 6-5
INHALATION UNIT RISKS AND SLOPE FACTORS
(Page 1 of 1)

Chemical	CAS Number	WOE(a)	Test Species	Exposure Media	Tumor site/ Critical Effect(s)	Unit Risk $(mg/m^3)^{-1}$	Source[b]	Slope Factor $(mg/kg\text{-}d)^{-1}$	Source[b]
Aroclor-1242	53469-21-9	B2		Food (RRE)	Liver			2	IRIS
Aroclor-1248	12672-29-6	B2		Food (RRE)	Liver			2	IRIS
Aroclor-1254	11097-69-1	B2		Food (RRE)	Liver			2	IRIS
Aroclor-1260	11096-82-5	B2		Food (RRE)	Liver			2	IRIS
Arsenic	7440-38-2	A	Human	Particulate	Lung	0.0043	IRIS	15	CALC
Benzene	71-43-2	A	Human		Leukemia	0.0000083	IRIS	0.029	HEAST
Benzo(a)pyrene	50-32-8	B2			Lung			6.1	ECAO
Benzo(b)fluoranthene	205-99-2	B2			Lung			0.61	ECAO
Beryllium	7440-41-7	B2	Human		Lung	0.0024	IRIS	8.4	HEAST
Bis(2-ethylhexyl)phthalate	117-81-7	B2							
Cadmium (food,soil)	7440-43-9	B1 (inhalation)	Human	Particulate	Respiratory tract	0.0018	IRIS	6.1	HEAST
Chloromethane	74-87-3	C	Mouse		Kidney	0.0000018	HEAST	0.0063	HEAST
Chromium (VI)	18540-29-9	A	Human	Particulate	Lung	0.012	IRIS	41	HEAST
Dichloroethane, 1,1-	75-34-3	C							
Dichloroethane, 1,2-	107-06-2	B2	Rat	Gavage (RRE)	Hemangiosarcomas, stomach	0.000026	IRIS	0.091	HEAST
Dichloroethene, 1,1-	75-35-4	C	Mouse		Kidney	0.00005	IRIS	1.2	HEAST
Lead	7439-92-1	B2							
Methylene chloride	75-09-2	B2	Mouse		Liver and lung	0.00000047	IRIS	0.0016	CALC
N-nitrosodiphenylamine	86-30-6	B2							
Tetrachloroethane, 1,1,2,2-	79-34-5	C	Mouse	Gavage (RRE)	Liver	0.000058	IRIS	0.2	HEAST
Tetrachloroethene	127-18-4	B2/C			Liver, leukemia	5.80E-07	ECAO	0.002	ECAO
Trichloroethane, 1,1,2-	79-00-5	C	Mouse	Gavage (RRE)	Liver	0.000016	IRIS	0.057	HEAST
Trichloroethene	79-01-6	B2/C			Lung	1.70E-06	ECAO	0.006	ECAO
Vinyl chloride	75-01-4	A	Rat		Liver	0.000084	HEAST	0.3	HEAST

a Weight of evidence (WOE) classification:

A	Human carcinogen.
B1 or B2	Probable human carcinogen.
B2/C	Probable/possible human carcinogen.
C	Possible human carcinogen.

b Codes used:

ECAO	Value issued by the Environmental Criteria and Assessment Ofice of the Superfund Technical Support Center (ECAO, 1995).
HEAST	Value from HEAST Table 3 (HEAST, 1995).
IRIS	Value from IRIS database (IRIS, 1996).
PRG	Provisional value from USEPA Region IX (PRG, 1996).
RRE	Route-to-route extrapolation by USEPA, based on oral data.
SUR	Surrogate value used; surrogate chemical in parentheses.
W	Value withdrawn from IRIS or HEAST.

TABLE 6-6
DERMAL SLOPE FACTORS

Chemical	CAS Number	WOE(a)	Oral Slope Factor (mg/kg-day)-1(a)	Oral Absorption Fraction(b)	Dermal Slope Factor (mg/kg-day)-1
Aroclor-1242	53469-21-9	B2	2	0.95 (c)	2.1E+00
Aroclor-1248	12672-29-6	B2	2	0.95 (c)	2.1E+00
Aroclor-1254	11097-69-1	B2	2	0.95 (c)	2.1E+00
Aroclor-1260	11096-82-5	B2	2	0.95 (c)	2.1E+00
Arsenic	7440-38-2	A	1.5	0.98 (c)	1.5E+00
Benzene	71-43-2	A	0.029	1 (c)	2.9E-02
Benzo(a)pyrene	50-32-8	B2	7.3	1	NA
Benzo(b)fluoranthene	205-99-2	B2	0.73	1	NA
Beryllium	7440-41-7	B2	4.3	0.005 (d)	8.6E+02
Bis(2-ethylhexyl)phthalate	117-81-7	B2	0.014	1	1.4E-02
Cadmium (soil)	7440-43-9	B1 (inhalation)	--	0.025 (e)	--
Chloromethane	74-87-3	C	1.3E-02	1	1.3E-02
Dichloroethane, 1,1-	75-34-3	C	--	1	--
Dichloroethane, 1,2-	107-06-2	B2	0.091	1	9.1E-02
Dichloroethene, 1,1-	75-35-4	C	0.6	0.93 (c)	6.5E-01
Lead	7439-92-1	B2	--	0.2 (d)	--
Mercury, inorganic	7439-97-6	C	--	0.02 (d)	--
Methylene chloride	75-09-2	B2	0.0075	1 (c)	7.5E-03
N-nitrosodiphenylamine	86-30-6	B2	0.0049	1	4.9E-03
Tetrachloroethane, 1,1,2,2-	79-34-5	C	0.2	1	2.0E-01
Tetrachloroethene	127-18-4	B2/C	0.052	1	5.2E-02
Trichloroethane, 1,1,2-	79-00-5	C	0.057	1	5.7E-02
Trichloroethene	79-01-6	B2/C	0.011	1	1.1E-02
Vinyl chloride	75-01-4	A	1.9	0.9 (c)	2.1

a See Table 4 for source of oral slope factors.
b An oral absorption fraction of 1 is assumed in the absence of data.
c Source = Owen (1990).
d Source = HEAST, Table 4 (HEAST, 1995).
e Source = IRIS (IRIS, 1996).
"--" = not available.

TABLE 6-7
PHYSICAL AND CHEMICAL PROPERTIES[a]
(Page 1 of 2)

Chemical	CAS Number	Molecular Weight (g/mole)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m3/mole)	Koc (ml/g)
			VOCs			
Acenaphthene	83-32-9	154.21	Insoluble	4.50E-03	7.92 E-5-2.41 E-4[b]	4.60E+03
Acetone	67-64-1	58.08	Completely Miscible	1.80E+02	4.26 E-5	5.40E+00
Anthracene	120-12-7	178.22	Virtually insol	1.70E-05	8.6 E-5	1.40E+04
Benzene	71-43-2	78.11	1.80E+03	9.50E+01	5.5 E-3	6.30E+01
Carbon Disulfide	75-15-0	76.14	2.30E+03	3.50E+02	1.22 E-2	no data
Chlorobenzene	108-90-7	112.56	5.00E+02	8.80E+00	3.58 E-3	3.30E+02
Chloroethane	75-00-3	64.52	5.68E+03	1.01E+03	1.11E-02	3.30E+01
Chloroform	67-66-3	119.38	7.20E+03	1.60E+02	3.67 E-3	4.50E+01
Dibenzofuran	132-64-9	168.19	1.0E+01[c]	4.4E-3[c]	9.73 E-5[c]	5.35E+02[c]
Dichlorobenzene, 1,4-	106-46-7	147.01	7.90E+01	1.76E+00	1.5 E-3	2.75E+02
Dichloroethane, 1,1-	75-34-3	98.97	0.55G/100G	2.30E+02	4.2 E-2	5.75E+01
Dichloroethane, 1,2-	107-06-2	98.96	8.69E+03	6.10E+01	1.10E-03	1.38E+01
Dichloroethene, 1,1-	75-35-4	96.95	2.5 E+3[c]	5.9 E+2	1.9 E-1	1.81E+00
Dichloroethene, Cis-1,2-	156-59-2	96.94	3.50E+03	2.20E+02	4.08 E-3	3.20E+01
Dichloroethene, Trans-1,2-	156-60-5	96.95[b]	6.30E+03	3.40E+02	9.38 E-3	3.20E+01
Ethylbenzene	100-41-4	106.16	1.61E+02	9.53E+00	7.9 E-3	1.65E+02
Fluorene	86-73-7	166.21	1.68E+00	1.00E+01	6.4 E-5	7.20E+03
Hexanone, 2-	591-78-6	100.16	1.74E+04[c]	1.2E+01[c]	3.39 E-5[c]	1.34E+02[c]
Methyl Ethyl Ketone	78-93-3	72.1	1.36E+05	9.06E+01	5.77E-05	3.55E+00
Methylene Chloride	75-09-2	84.93	1.67E+04	3.49E+02	2.03E-03	2.50E+01
Methylnaphthalene, 2-	91-57-6	142.2[c]	--	6.81E-02[c]	5.18E-04[c]	8.5E+03[c]
N-Nitrosodiphenylamine	86-30-6	198.23	4.00E+01	1.00E-01	6.6 E-4	8.32E+02
Naphthalene	91-20-3	128.16	3.17E+01	8.70E-02	4.60E-04	9.33E+02
Phenanthrene	85-01-8	178.22	1.00E+00	9.60E-04	2.26 E-4	1.41E+04
Tetrachloroethane, 1,1,2,2-	79-34-5	167.85	2.87E+03	5.95E+00	4.70E-04	4.57E+01
Tetrachloroethene	127-18-4	165.83	1.50E+02	1.85E+01	1.8 E-02	1.58E+02
Toluene	108-88-3	92.13	5.35E+02	2.84E+01	5.94E-03	3.72E+01
Trichloroethane, 1,1,1-	71-55-6	133.42	0.001495%	1.24E+02	6.3 E-3	1.05E+02
Trichloroethane, 1,1,2-	79-00-5	133.42	4.40E+03	2.25E+01	9.1 E-4	1.15E+01
Trichloroethene	79-01-6	131.4	1.37 E+4	74	1.1 E-2	1.0 E+2[c]
Vinyl Chloride	75-01-4	62.5	2.76 E+3	2.53 E+3	1.2	9.77 E+1
Xylenes	1330-20-7	106.16	1.30E+02	6.00E+00	o-xylene 5.2 E-3	1.29E+02
			SVOCs			
Aroclor 1242	53469-21-9	266.5	3.40E-01	4.06E-04	5.20E-04	--
Aroclor-1248	12672-29-6	299.5	6.00E-02	4.94E-04	2.80E-03	--
Aroclor-1254	11097-69-1	327	5.70E-02	7.71E-05	2.0 E-3	--
Aroclor-1260	11096-82-5	372	8.00E-02	4.05E-05	4.6 E-3	--
Benzo(a)Anthracene	56-55-3	228.29	1.40E-02	2.20E-08	1.00E-06	2.00E+05
Benzo(a)Pyrene	50-32-8	252.3	3.8	5.6 E-9	4.9 E-7	5.5 E+6
Benzo(ghi)perylene	191-24-2	276.34	2.60E-03	1.03E-10	1.44E-07	1.58E+06
Benzo(b)fluoranthene	205-99-2	252.3	1.20E-03	5.74E+00	1.22E-05	5.50E+05
Bis(2-Ethylhexyl)Phthalate	117-81-7	390.57	2.85E-01	6.20E-08	1.10E-05	1.00E+05
Chlordane, gamma	5103-74-2	409.76	5.60E-02	2.20E-05	4.80E-05	2.00E+06
Chrysene	218-01-9	228.3	2.20E+03	6.30E-09	1.05E-06	2.00E+05
Dibenz(a,h)Anthracene	53-70-3	278.35	5.00E-07	1.00E-10	7.30E-08	3.31E+05
Fluoranthene	206-44-0	202.26	0.26[c]	1.00E-02	6.50E-06	3.80E+04
Heptachlor	76-44-8	373.35	5.00E-02	3.00E-04	1.48E-03	2.19E+04
Indeno(1,2,3-cd)Pyrene	193-39-5	276.3	6.20E-02	1.00E-10	6.95E-08	1.58E+06

TABLE 6-7
PHYSICAL AND CHEMICAL PROPERTIES[a]
(Page 2 of 2)

Chemical	CAS Number	Molecular Weight (g/mole)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m3/mole)	Koc (ml/g)
		Inorganics				Kd (mL\g)
Aluminum	7429-90-5	26.98	--	--	--	1500
Antimony	7440-36-0	121.75	--	--	--	81-185
Arsenic	7440-38-2	74.92	--	--	--	1.0-37
Barium	7440-39-3	137.3	--	--	--	530-16000
Beryllium	7440-41-7	9.01	--	--	--	70-8000
Cadmium	7440-43-9	112.41	--	--	--	1.26-17000
Calcium	7440-70-2	40.08[b]	--	--	--	1.2-9.8
Cobalt	7440-48-4	58.93[c]	--	--	--	0.2-3800
Copper	7440-50-8	63.55	--	--	--	1.4-336
Iron	7439-89-6	55.85[c]	--	--	--	1.4-10100
Lead	7439-92-1	207.2	--	--	--	4.5-7650
Manganese	7439-96-5	54.94	--	--	--	0.2-10000
Magnesium	7439-95-4	24.31	--	--	--	--
Mercury	7439-97-6	201	--	--	--	322-5280
Nickel	7440-02-0	58.69	--	--	--	1.2-4700
Potassium	7440-09-7	39.1	--	--	--	2.0-9.0
Selenium	7782-49-2	78.96	--	--	--	5.9-1800
Silver	7440-22-4	107.87	--	--	--	10-1,000
Sodium	7440-23-5	22.99[c]	--	--	--	100
Thallium	7440-28-0	204.38	--	--	--	0.0-0.8
Vanadium	7440-62-2	50.94	--	--	--	1000

a Values obtained from ATSDR unless noted otherwise.
b Montgomery and Welkom (1989).
c HSDB (1995).
"--" = Not available.

TABLE 6-8
CHEMICAL HALF-LIVES[a]
(Page 1 of 1)

Chemical	CAS Number	Half-Life (days)[a] Soil High	Soil Low	Air High	Air Low	Groundwater High	Groundwater Low
VOCs							
Acenaphthene	83-32-9	102	12.3	0.37	0.037	204	24.6
Acetone	67-64-1	7	1	116	11.6	14	2
Anthracene	120-12-7	460	50	0.071	0.024	920	100
Benzene	71-43-2	16	5	20.9	2.09	720	10
Carbon Disulfide	75-15-0			9[b]			
Chlorobenzene	108-90-7	150	68	30.4	3	300	136
Chloroethane	75-00-3	28	7	66.8	6.67	56	14
Chloroform	67-66-3	180	28	260	26	1800	56
Dibenzofuran	132-64-9	28	7	0.79	0.79	35	8.5
Dichlorobenzene, 1,4-	106-46-7	180	28	83.6	8.4	360	56
Dichloroethane, 1,1-	75-34-3	154	32	103	10.3	360	64
Dichloeoethane, 1,2-	107-06-2	180	100	122	12.2	360	100
Dichloroethene, 1,1-	75-35-4	180	28	4	0.4	132	56
Dichloroethene, Cis-1,2-	156-59-2	180	28	12	1	2875	56
Dichloroethene, Trans-1,2-	156-60-5			3.6[b]			
Ethylbenzene	100-41-4	10	3	3.57	0.357	228	6
Fluorene	86-73-7	60	32	2.8	0.28	120	64
Hexanone, 2-	591-78-6						
Methyl Ethyl Ketone	78-93-3	7	1	26.7	2.7	14	2
Methylene Chloride	75-09-2	28	7	191	19.1	56	14
Methylnaphthalene, 2-	91-57-6			2.25[b]			
N-Nitrosodiphenylamine	86-30-6	34	10	0.29	0.029	68	20
Naphthalene	91-20-3	48	16.6	1.23	0.12	258	0.5
Phenanthrene	85-01-8	200	16	0.84	0.084	400	32
Tetrachloroethane, 1,1,2,2-	79-34-5	45	0.45	88.8	8.9	45	0.45
Tetrachloroethene	127-18-4	365	180	160	16	730	365
Toluene	108-88-3	22	4	4.3	0.42	28	7
Trichloroethane, 1,1,1-	71-55-6	273	140	2247	225	546	140
Trichloroethane, 1,1,2-	79-00-5	365	136	81.5	8.2	730	136
Trichloroethene	79-01-6	360	180	11.3	1.1	1653	321
Vinyl Chloride	75-01-4	180	28	4.041667	0.4042	2875	56
Xylenes	1330-20-7	28	7	1.8	0.11	365	14
SVOCs							
Aroclor 1242	53469-21-9	--	--	--	--	--	--
Aroclor-1248	12672-29-6	--	--	--	--	--	--
Aroclor-1254	11097-69-1			11[b]	>4[b]		
Aroclor-1260	11096-82-5						
Benzo(a)Anthracene	56-55-3	680	102	0.125	0.042	1360	204
Benzo(a)Pyrene	50-32-8	530	57	0.046	0.015	1060	114
Benzo(ghi)perylene	191-24-2	650	590	0.134	0.013	1300	1180
Benzo(b)fluoranthene	205-99-2	610	360	0.596	0.06	1220	720
Bis(2-Ethylhexyl)Phthalate	117-81-7	23	5	1.21	0.121	389	10
Dibenz(a,h)anthracene	53-70-3	940	361	0.178	0.0179	1880	722
Fluoranthene	206-44-0	440	140	0.842	0.084	880	280
Indeno(1,2,3-c,d)Pyrene	193-39-5	730	600	0.262	0.026	1460	1200

a Values obtained from Howard (1989) unless noted otherwise.
b HSDB (1995).

7.0 RISK CHARACTERIZATION

This section of the risk assessment will characterize the potential noncarcinogenic and carcinogenic health risks for the exposure scenarios identified in the exposure assessment. The potential health risks will be characterized separately for noncarcinogenic and carcinogenic endpoints. These endpoints will be characterized by comparing calculated dose levels to maximum "acceptable" doses. The potential noncarcinogenic health risks will be determined using the Hazard Quotient/Index approach that defines the relative hazard based on the ratio of the estimated average daily dose to the acceptable intake level (*i.e.*, the RfD). The potential carcinogenic health risks will be determined based on the probability that an individual may contract cancer in a lifetime from the estimated lifetime average daily dose. The methodologies that will be used to characterize potential risks at the GE facility are presented below.

The risk characterization section of the risk assessment will present the hazard indices and theoretical cancer risks for all chemicals identified as PCOIs.

7.1 Noncarcinogenic Effects

Noncarcinogenic health risks are typically characterized using a "hazard quotient" and "hazard index" approach (USEPA, 1989a). The hazard quotient (HQ) is the ratio of the calculated ADD to the maximally allowable "safe" dose (*i.e.*, USEPA reference levels such as the RfD or similar value). The equation used to calculate the hazard quotient for a chemical is presented below.

$$Hazard\ Quotient = \frac{ADD}{RfD}$$

An HQ of 1 or less indicates that the chemical-specific ADD for a particular pathway is below the level associated with an adverse health effect. Additive noncarcinogenic health effects can be evaluated when exposure to more than one chemical occurs by using the hazard index (HI) approach. The HI accounts for potential additivity of effects from chemicals which affect a similar biological endpoint, or target organ. It will be initially assumed that all effects are additive (*i.e.*, the HI approach will be used to assess the aggregate risks from multiple chemicals). The risk assessment may also provide the justification for evaluating noncarcinogenic hazards on a target organ-specific basis, as needed. The simplified equation for calculating a generic HI is presented below.

$$Hazard\ Index = \frac{ADD_1}{RfD_1} + \frac{ADD_2}{RfD_2} + \ldots + \frac{ADD_n}{RfD_n}$$

A hazard index (HI) of 1 or less indicates that levels of exposure are acceptable. Three types of HIs will be calculated to assist in the risk characterization process. These include (1) a chemical-specific HI (presents the aggregate risk across all exposure pathways on a chemical-specific basis), (2) a pathway-specific HI (presents the aggregate risk considering all COIs on a pathway-specific basis), and (3) a total HI (presents the aggregate risk for all COIs across all exposure pathways on a scenario-specific basis). The chemical- and pathway-specific HIs will be presented to determine the relative contribution of each COI and exposure pathway, respectively, to the potential health risks for a particular scenario. The total HI is representative of the total dose received by an individual from all chemicals across all pathways and will provide an upper-bound value of the potential health risks associated with the scenario under consideration. As the USEPA (1989a) notes:

> There are two steps required to determine whether risks or hazard indices for two or more pathways should be combined for a single exposed individual or group of individuals. The first is to identify reasonable exposure pathway combinations. The second is to examine whether it is likely that the <u>same</u> individuals would <u>consistently</u> face the "reasonable maximum exposure" (RME) for more than one pathway.

Conservatively, all exposure pathways evaluated will be combined and initially the <u>same</u> individual will be assumed to be consistently exposed to RME conditions.

7.2 Theoretical Carcinogenic Risks

Theoretical carcinogenic health risks are defined in terms of a probability that an individual may develop cancer as a result of exposure to a given chemical at a given concentration (USEPA, 1989a). The incremental probability of developing cancer (*i.e.*, the theoretical excess cancer risk) is the additional risk above and beyond the cancer risk an individual would face in the absence of exposures characterized in this assessment. The theoretical excess cancer risk will be determined for each potentially carcinogenic chemical using the total LADD from all pathways and cancer slope factors as described below.

$$Theoretical\ Risk = LADD * SF$$

where:

LADD	=	Lifetime average daily dose (mg/kg-day); and
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$.

The LADD and SF are multiplied yielding a dimensionless value that represents the probability of developing cancer within a lifetime (70 years) due to the chemical dose (LADD) received by a person. For example, a theoretical risk value of 0.0001 or 1×10^{-4}, is referred to as a probability of 1 in 10,000 in developing cancer. As with the HIs, the theoretical excess cancer risk will be presented for each scenario on a chemical-specific, pathway-specific, and total risk basis. The theoretical excess cancer risk will be evaluated using both the *de minimus* lifetime cancer risk rate of $1x10^{-6}$ (*i.e.*, zero risk) and the acceptable regulatory risk range of $1x10^{-6}$ to $1x10^{-4}$ (OSWER Directive 9355.0-30 (USEPA, 1991c)).

7.3 Qualitative Uncertainty Analysis

A qualitative discussion of the uncertainties associated with each component of the risk assessment will be provided including:

- **Site Characterization** - The degree of confidence in the current and future land use determinations will be addressed.

- **Data Evaluation** - The potential impacts of using estimated concentra-tions, treatment of nondetect values, and the exclusion of chemicals and data from the risk assessment will be addressed. Residual risks associated with exposure to chemicals excluded from the risk assessment will be evaluated qualitatively and/or quantitatively.

- **Toxicity Assessment** - Uncertainties surrounding the toxicity values (RfDs and SFs), weight-of-evidence classifications, toxicity value data gaps, and route-to-route extrapolations will be addressed.

- **Exposure Assessment** - Uncertainties surrounding fate and transport modeling, and the assignment of exposure parameter values will be addressed.

- **Risk Characterization** - Uncertainties surrounding the practice of summing HIs and risks across chemicals and pathways will be addressed.

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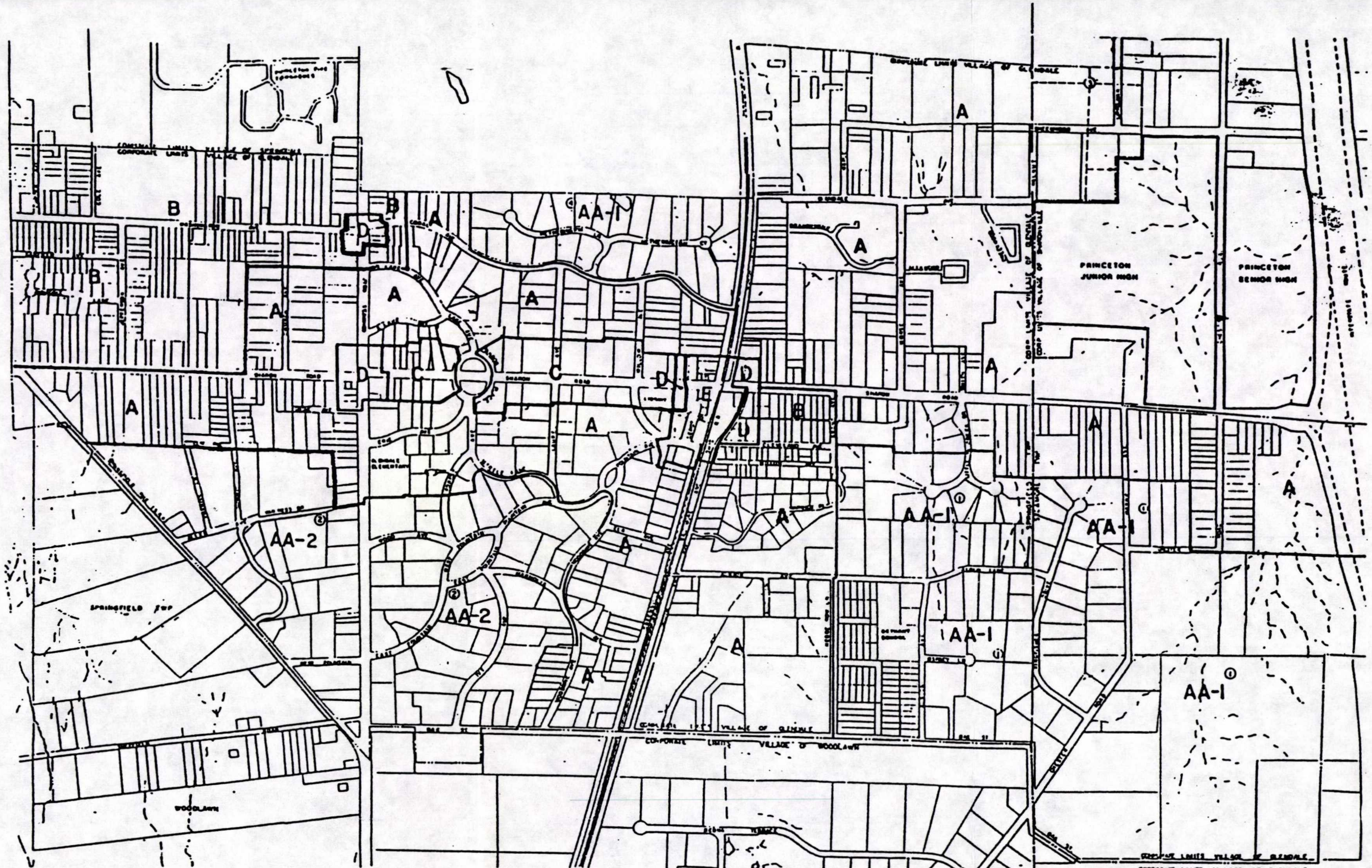
ATTACHMENT A

ZONING MAPS


ZONING MAP
VILLAGE OF
EVENDALE
HAMILTON COUNTY, OHIO
ORDINANCE NO. 56-88
ADOPTED FEBRUARY 9, 1989
EFFECTIVE MARCH 11, 1989
KEY TO ZONING DISTRICTS
"R" RESIDENTIAL
"GC" GENERAL COMMERCIAL
"HC" HEAVY COMMERCIAL
"GI" GENERAL INDUSTRIAL
"ITC" INDUSTRIAL TRUCK CENTER
"OR" OFFICE/RESEARCH
"PF" PUBLIC FACILITY
"OR-PBD" OFFICE/RESEARCH PLANNED BUSINESS DEVELOPMENT
"GB" GREEN BELT
N
200 600 1000
0 400 800 1200
SCALE IN FEET
4-7-87 SANDERS PLACE SUBD.
4-7-87 COOPER HILL SUBD.
4-7-87 PARK HILLS SUBD.
6-30-88 VARIOUS ZONE CHANGES
2-1-89 CARPENTERSVIEW SUBD.
& VARIOUS CHANGES
DATE ITEM DATE ITEM
REVISIONS
REVISIONS
9-2-89 ordinance 31-89
11-2-89 ordinance 69-89
TES, INC.
TECTS
513-793-7410
SHARON RD.
Medallion Drive
MAGNO DRIVE
McSWAIN DR.
WYSCARVER RD.
MARGATE TER.
MARGATE TER.
OAK AVE.
READING RD.
GLENDALE-MILFORD RD.
PLAINFIELD RD.
WOODLEIGH LA.
MOORHILL DR.
MONETS LANE
INWOOD DRIVE
TURGOT CIR.
BRAEWOOD DRIVE
CLAYTON TRAIL
SHERBROOKE DRIVE
BOXWOOD CIR.
BRINTON TRAIL
CARPENTERSVIEW DR.
CARPENTERSCREEK DRIVE
FAWNRUN DRIVE
VINEYARD RIDGE
RENOIR PLACE
PHEASANTWALK CT.
TWILIGHT DR.
PLATEAU PLACE
COOPER RD.
MONLER RD.
STANWIN PLACE
WINNEBAGO TR.
OTTERSEIN RD.
LAMARQUE DR.
REDFORD DRIVE
SPARTAN DR.
C.C.C. & ST. L. RR
READING ROAD
P. G. GRAVES LA.



VILLAGE OF GLENDALE, OHIO
DISTRICT MAP

THIS IS TO CERTIFY THAT THIS IS THE "DISTRICT MAP" A PART OF CHAPTER 154 OF THE CODE OF THE VILLAGE OF GLENDALE, OHIO ADOPTED THIS 7 TH DAY OF OCTOBER 1983.

MAYOR

ATTEST:

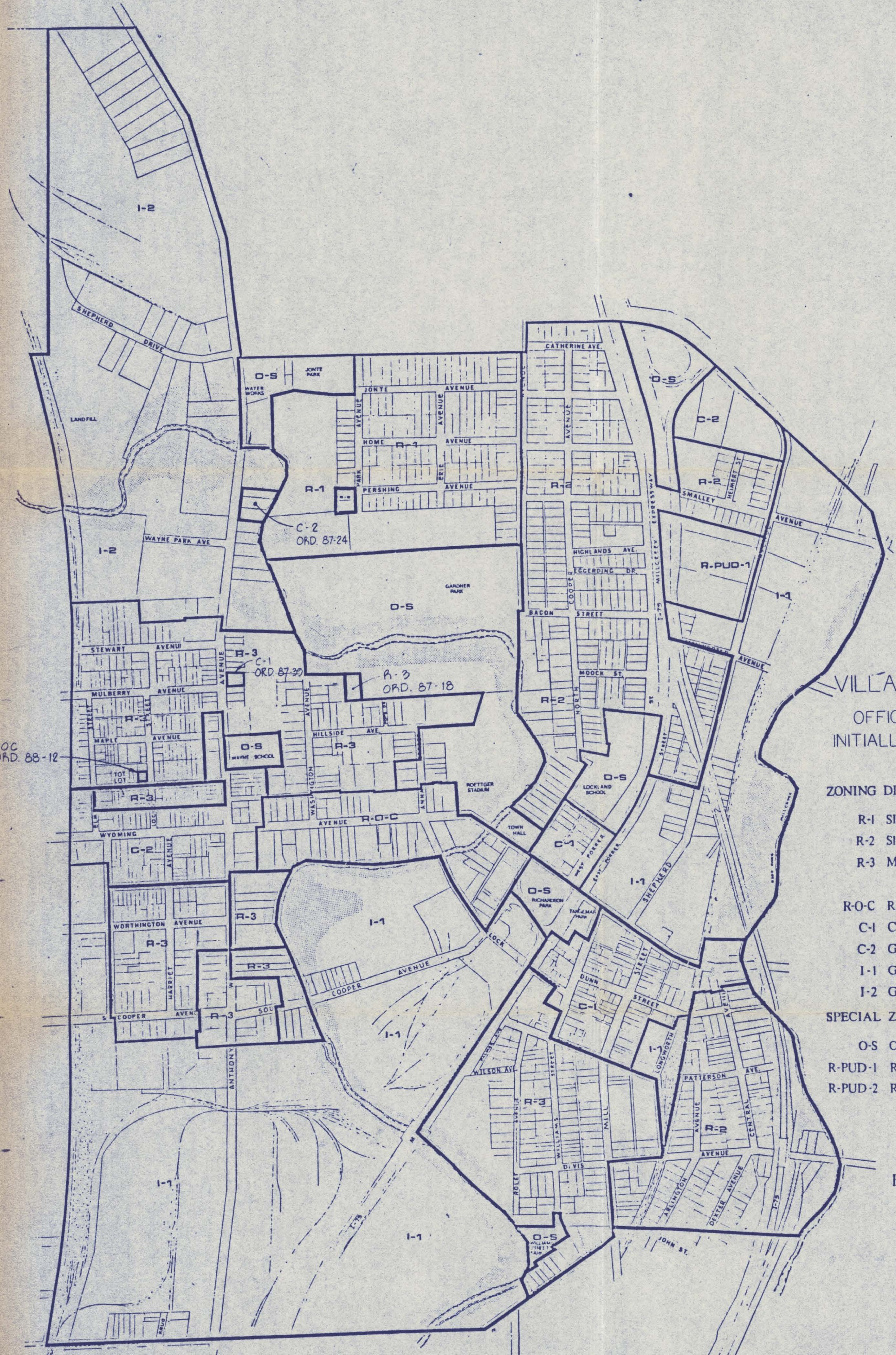
VILLAGE CLERK

CHANGE SUMMARY

① ZONE CHANGE ORD. NO. 6 1946
② ZONE CHANGE ORD NO 6 1946
③ ANNEXED ORD NO 8 1953
④ ZONE CHANGE ORD NO. 1983-23

LEGEND & SUMMARY OF ZONING REGULATIONS

DISTRICT	USE	HEIGHT		FRONT YARD	SIDE YARD	REAR YARD	LOT AREA PER FAMILY	MINIMUM LOT WIDTH	MINIMUM SQ. FT. PER DWELLING UNIT
		STORIES	FEET						
AA-1	SINGLE FAMILY DWELLINGS, PARKS, CHURCHES, PUBLIC SCHOOLS, EDUCATIONAL AND OTHER INSTITUTIONS, CLUBS, AND CERTAIN OTHER UNUSUAL USES BY SPECIAL PERMIT.	2 1/2	35	40	15	40	43560	100	1500
AA-2		2 1/2	35	40	15	40	22500	75	1500
A		2 1/2	35	40	10	40	15000	60	1200
B		2 1/2	35	30	7	30	7500	50	1000
C	TWO FAMILY DWELLINGS BY SPECIAL PERMIT	2 1/2	35	30	7	30	15000	60	1200
D	RETAIL USES, RESIDENTIAL USES ON SECOND FLOOR	2 1/2	35	30	None	20	5000	50	1000
E	USES PERMITTED IN "D" DISTRICT GARAGES, CERTAIN REPAIR SHOPS, BAKERIES	2 1/2	35	30	None	15	5000	50	1000



VILLAGE OF LOCKLAND, OHIO

OFFICAL ZONING DISTRICT MAP

INITIALLY ADOPTED FEBRUARY, 1984

REVISED MARCH, 1989

ZONING DISTRICTS

R-1 SINGLE-FAMILY RESIDENTIAL DISTRICT

R-2 SINGLE-FAMILY RESIDENTIAL DISTRICT

R-3 MEDIUM DENSITY RESIDENTIAL DISTRICT

R-O-C RESIDENTIAL-OFFICE COMMERCIAL DISTRICT

C-1 CENTRAL COMMERCIAL DISTRICT

C-2 GENERAL COMMERCIAL DISTRICT

I-1 GENERAL INDUSTRIAL DISTRICT

I-2 GENERAL INDUSTRIAL DISTRICT

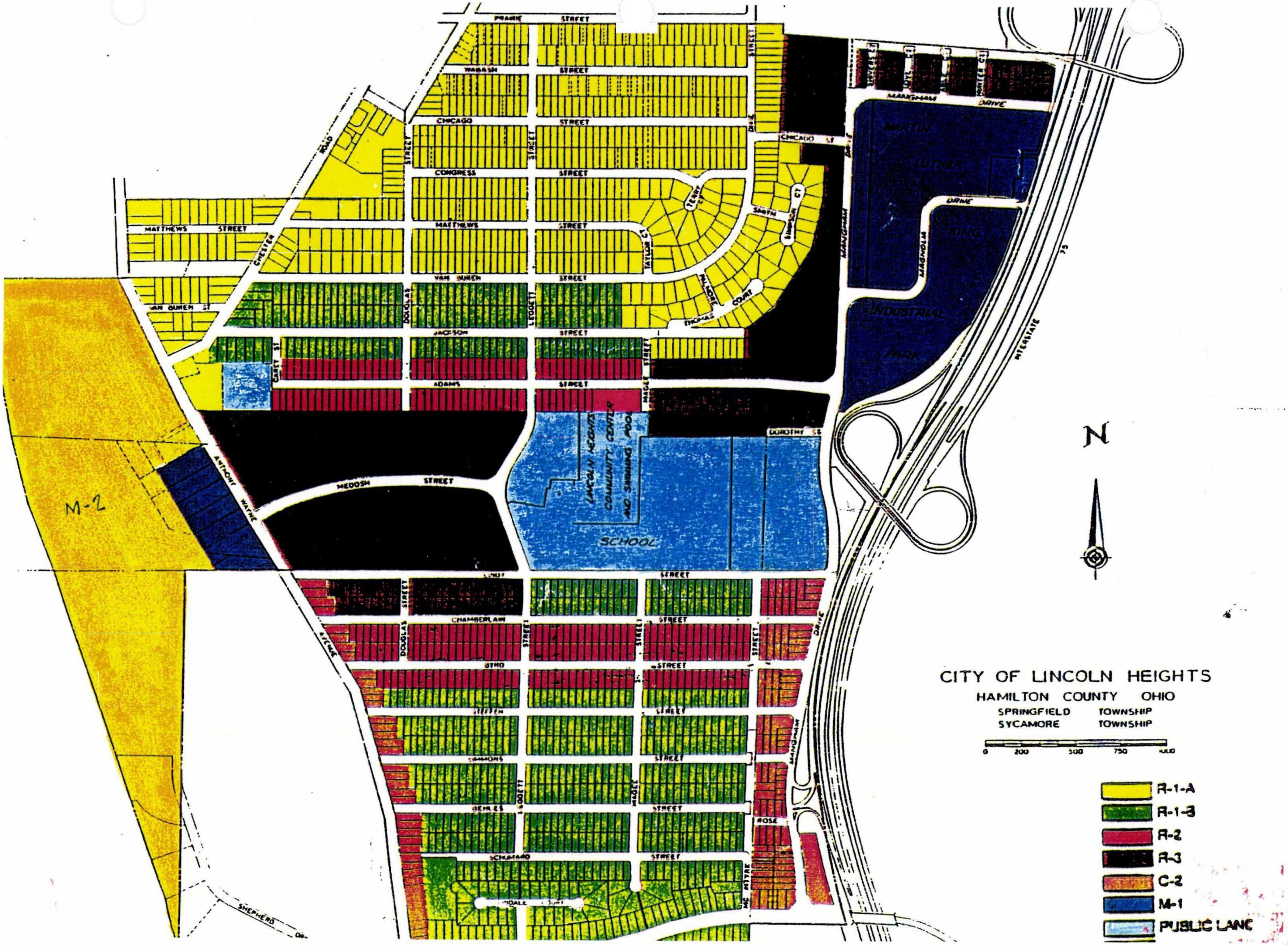
SPECIAL ZONING DISTRICTS

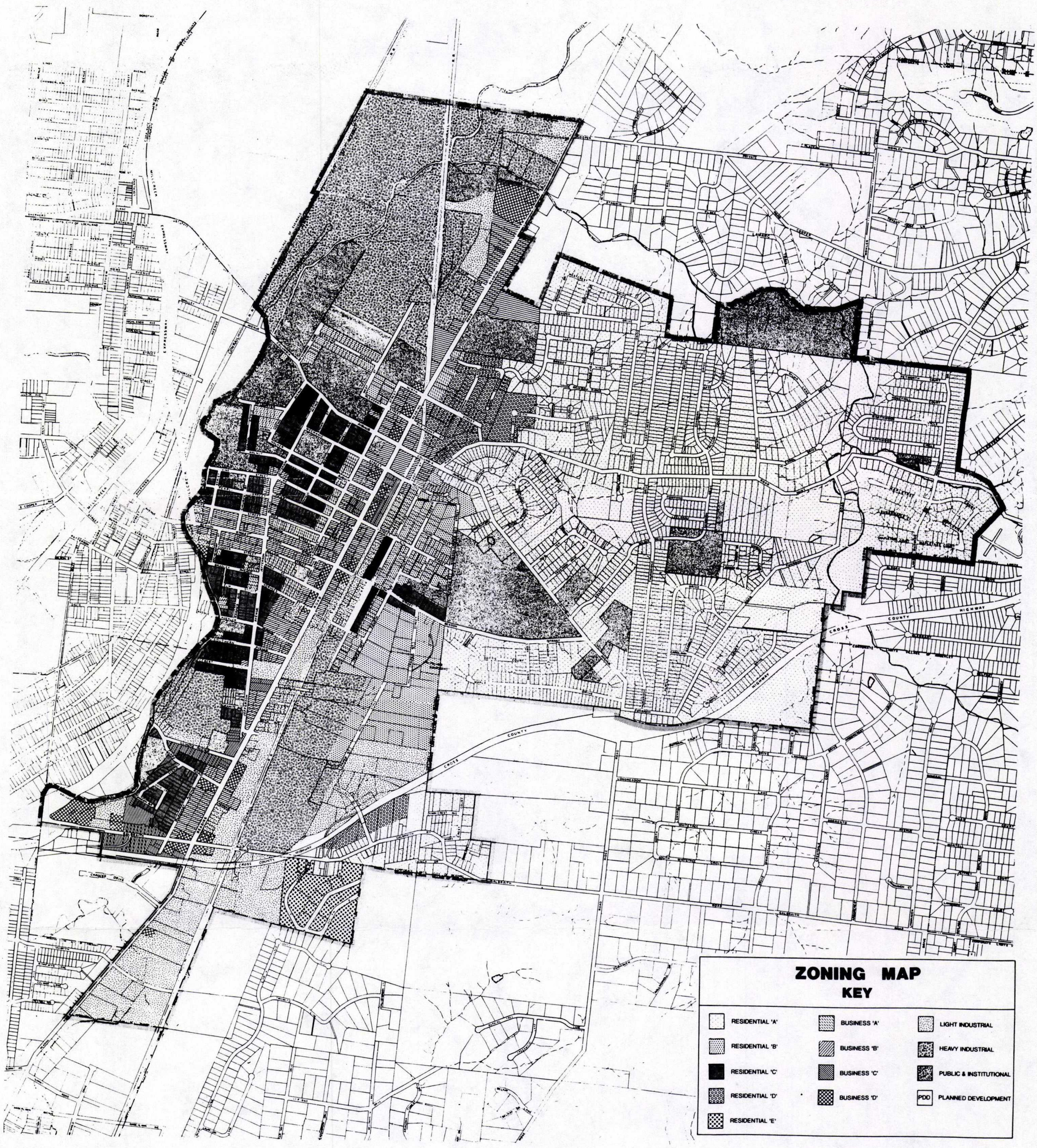
O-S OPEN SPACE AND PUBLIC LAND DISTRICT

R-PUD-1 RESIDENTIAL DEVELOPMENT PUD

R-PUD-2 RESIDENTIAL REDEVELOPMENT PUD

FP-D 100-YEAR FLOOD PLAIN


CITY OF LINCOLN HEIGHTS
HAMILTON COUNTY OHIO
SPRINGFIELD TOWNSHIP
SYCAMORE TOWNSHIP
0 200 500 750 1000
N
R-1-A
R-1-B
R-2
R-3
C-2
M-1
PUBLIC LAND
M-2
PRAIRIE STREET
WABASH STREET
CHICAGO STREET
CONGRESS STREET
MATTHEWS STREET
VAN BUREN STREET
VAN BUREN ST
JACKSON STREET
ADAMS STREET
MEDOSH STREET
LINDY STREET
CHAMBERLAIN STREET
OTHO STREET
STEFFEN STREET
SIMMONS STREET
BEHLES STREET
SCHUMARD STREET
CHESTER ROAD
DOUGLAS STREET
LEGGETT STREET
MAGEE STREET
CAREY ST
TAYLOR CT
TERRY CT
SMITH
SIMPSON CT
PALMORE
THOMAS COURT
CHICAGO ST
MANGHAM DRIVE
MAGNOLIA DRIVE
DOROTHY ST
MARTIN LUTHER KING INDUSTRIAL PARK
INTERSTATE 75
ANTHONY WAYNE AVENUE
LINCOLN HEIGHTS COMMUNITY CENTER AND SWIMMING POOL
SCHOOL
ROSE
MC INTYRE
SHEPHERD



City of Reading

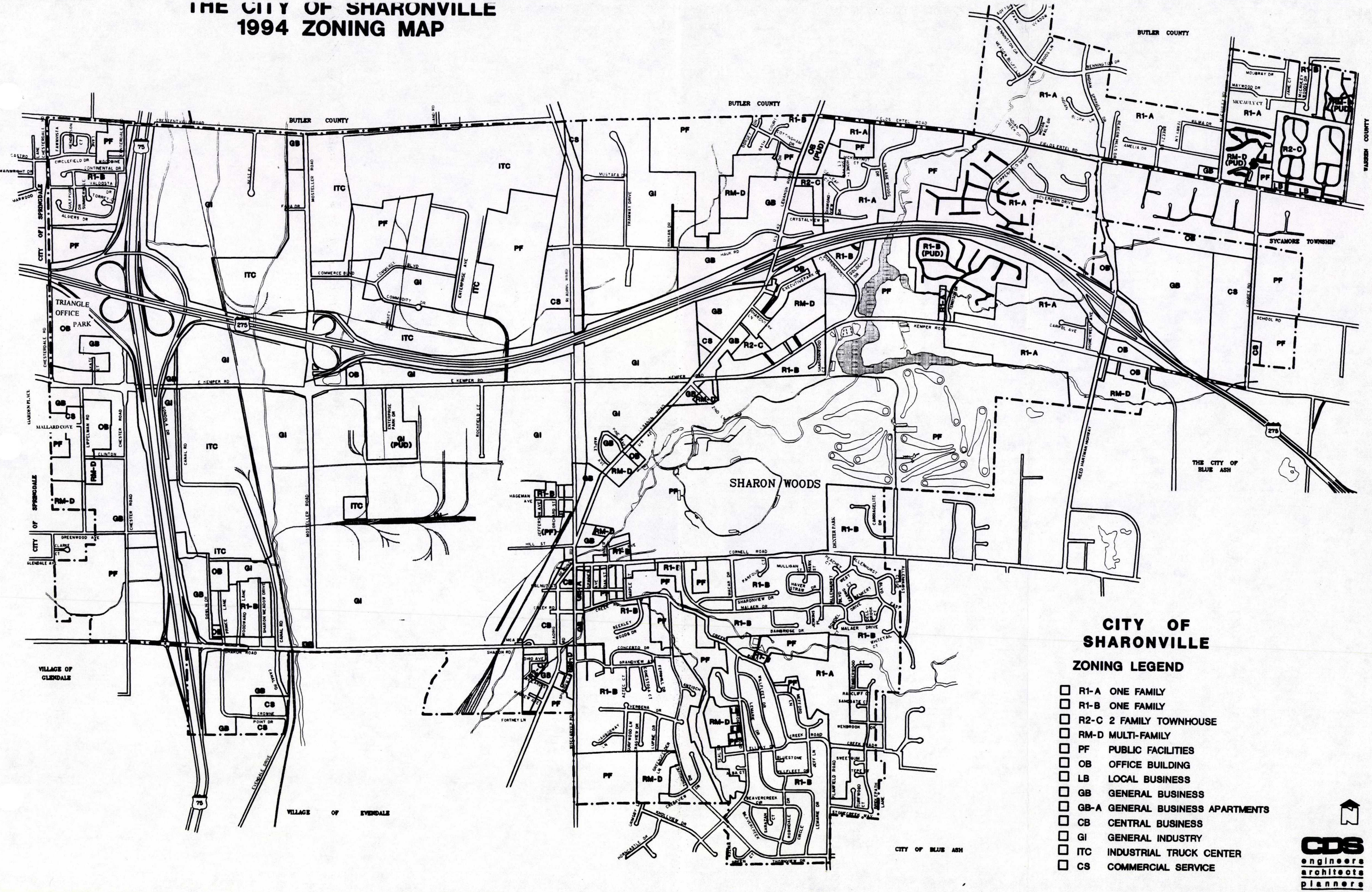
0 400 1600

N

REVISIONS:

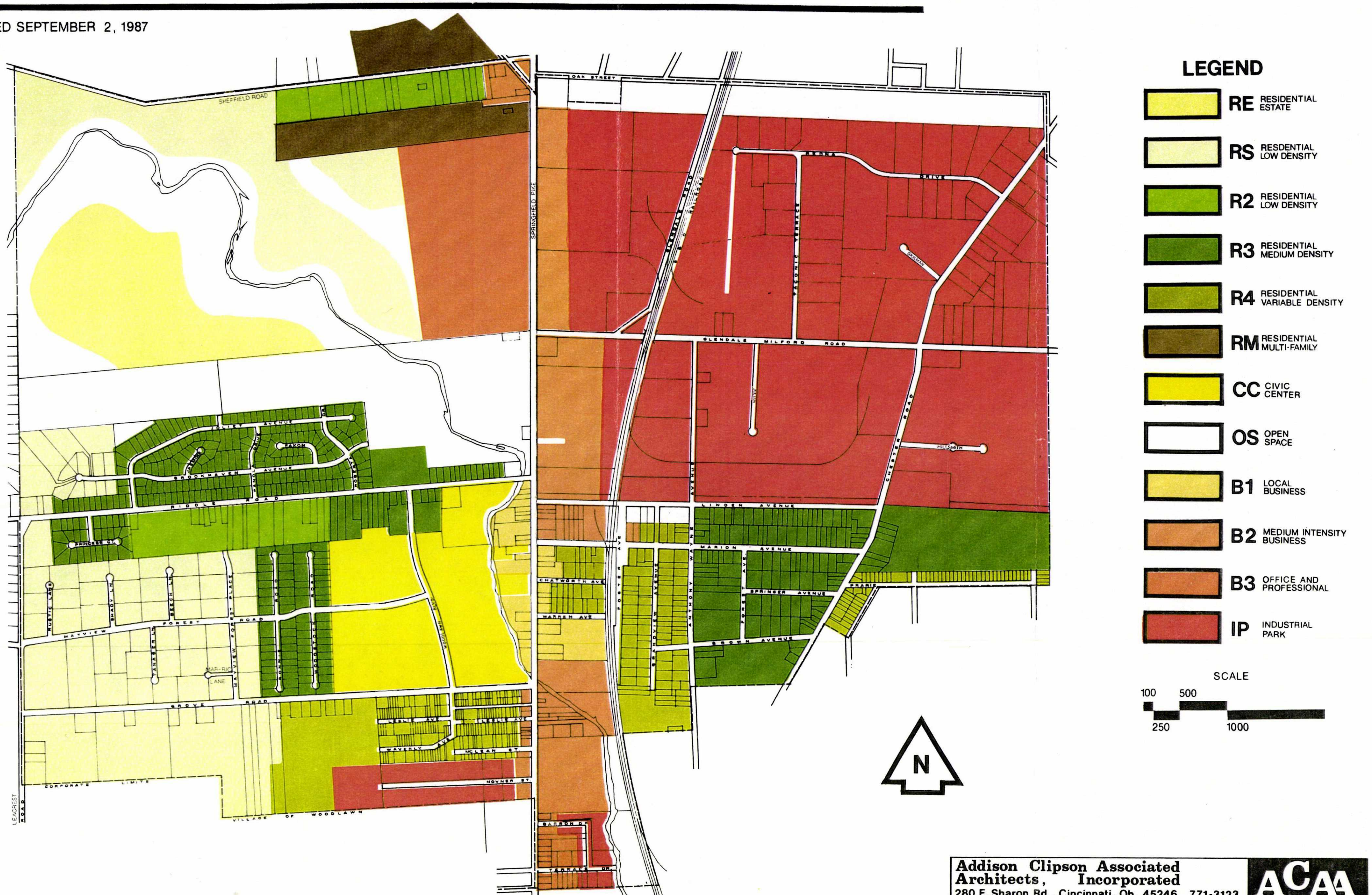
1/92 NEW ZONING MAP	
2 June 92 - Ord. 92-86	
16 June 92 - Ord. 92-90	

THE CITY OF SHARONVILLE 1994 ZONING MAP



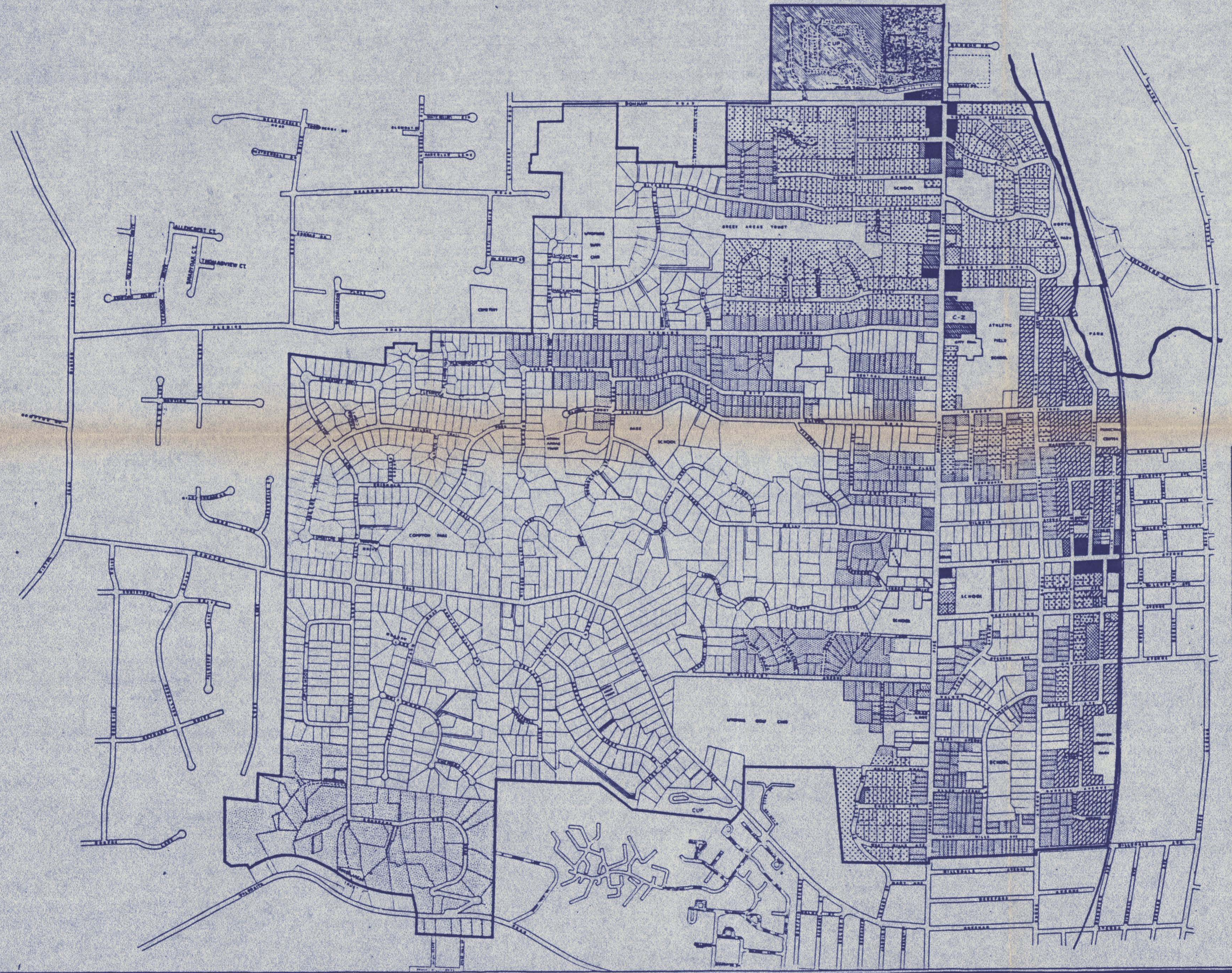
VILLAGE OF WOODLAWN, OHIO ZONING MAP

ADOPTED SEPTEMBER 2, 1987



CITY OF WYOMING & ENVIRONS

HAMILTON COUNTY OHIO



OFFICIAL ZONING MAP

SYMBOL	DISTRICT	USE	LOT AREA PER FAMILY
	AAAA	SINGLE-FAMILY RESIDENCE	40,000 SQ. FT.
	AAA	SINGLE - FAMILY RESIDENCE	20,000 SQ. FT.
	AA	SAME AS "AAA"	12,000 SQ. FT.
	A	SAME AS "AAA"	7,500 SQ. FT.
	B	TWO - FAMILY RESIDENCE	6,000 SQ. FT. / 1-FAMILY 5,000 SQ. FT. / 2-FAMILY
	C-1	FOUR - FAMILY RESIDENCE	6,000 SQ. FT. / 1-FAMILY 5,000 SQ. FT. / 2-FAMILY 5,000 SQ. FT. / MULT. DWEL.
	C-2	PLANNED MULTI - FAMILY RESIDENCE	SAME AS "C-1"
	C-3	FOUR - FAMILY RESIDENCE PLUS OFFICE USE	SAME AS "C-1"
	E	COMMERCIAL	SAME AS "C-1"
	EE	PLANNED SHOPPING	SAME AS "C-1"
	F	LIGHT INDUSTRIAL	SAME AS "C-1"

REVISED JAN 1981

REVISED JAN. 1991